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# JPRS Report

# Science & Technology

## China

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CONTENTS

## TELECOMMUNICATIONS R&D



## PHYSICS

## Issues Facing Military Industry Research

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[Article by Wu Shanggui [2976 1424 6311]: "Problems and Countermeasures Facing Military Industry Research"]

[Text] Most of the military-industry research facilities in China were established in the mid 1960's in response to worldwide tension. However, similar to what is happening in other countries, this defense-oriented technology team is facing a serious issue in peace time, i.e. how to survive in a peaceful environment.

I. Two challenges facing military-industry research.

In the past, this enormous defense-oriented technology team relied totally on government support. In peace time, these military-industry research institutions are facing two fundamental changes in their environment. One is a challenge to their existence due to a serious cutback in the defense-oriented research budget. There is a serious shortage of military research projects to the extent that some institutions are running out of money. The other serious challenge is the new-technology revolution in the world. Military technology is making rapid advances in some developed nations. There is a danger that the gap in military technology between China and those countries will continue to widen, thus making catching up a much more difficult task.

II. A potential crisis in military-industry research.

Under the influence of product-oriented economy, some leaders have mistakenly leaned toward chasing after short-term gains. They concentrated their efforts toward generate more revenues by encouraging their technical staffs to get involved in the development of highly profitable and popular projects. Some institutions have changed their original research directions and mobilized some highly talented people to work on "revenue-producing" projects that are totally unrelated to their field of expertise. Some research management institutions used income as a criterion to evaluate and review various research institutions. Some research institutions even imposed annual revenue quotas for their technical staffs to fulfill. If the quotas are not met, bonuses are cut. Therefore, many technical people prefer short-term projects and ignore long-term projects. They value projects involving commercial products and despise projects involving products for military use. Product-development projects are "hot" and basic-research projects are "cold." In summary, the selection of projects is strictly based on profit. On the surface, this shows tremendous enthusiasm toward generating higher profits. However, there is a hidden crisis for military-industry research which will cause irrevocable damage to the entire defense-oriented industry.

III. Three countermeasures for the survival and growth of military-industry research

(1) Make overall arrangements to combine long- and short-term projects.

In most military-industry research institutions, long- and short-term projects are inter-related and mutually complementary; they must be balanced. However, long-term projects usually have relatively high starting points, have more technical hurdles, require longer research periods, are higher-risk investments, and cannot produce results in the near term. Therefore, most research institutions and researchers are not willing to work on long-term projects. Of course, in view of the fact that some research institutions are running out of government funding, it is perfectly understandable why they are giving priority to short-term projects in order to generate some income in the immediate future to support their employees. However, from a standpoint of long-range growth and strategy, in addition to concentrating most of their resources on technical development during the initial phase of transition from military to commercially oriented applications, military-industry research institutions must also assign a considerable amount of their key technical resources to undertake some high-level long-range military projects and to track and move ahead of world-class level in order to maintain some military technology reserve that is compatible with our defense strategy.

(2) Combine "longitudinal and lateral" projects in order to mix profitable and not-so-profitable projects.

Military-industry research institutions are facing another major problem, i.e., profits from longitudinal and lateral projects are unequal. Technical people working on longitudinal military products have to work very hard for years to overcome technical hurdles. However, they receive much less rewards than those engaged in commercial products. In order to solve this dilemma, we recommend adopting the following three measures. Technical people who are assigned to long-term military-oriented projects by government directives will be supported and protected. Their incomes, bonuses and benefits will be appropriately taken care of in order ensure that their bonuses are not less than or slightly higher than those involved in commercial projects. Next, areas such as performance review, job assignment, housing, employment of dependent children, [and treatment of] technical people who have made significant contribution to military products will be given priority when everything else is equal. This is intended to stabilize a key military research team. Finally, administrative intervention will be imposed on research institutions that are only willing to work on commercial product development and will not accept military-research projects. They will be ordered to undertake a fixed number of military-oriented projects and complete them on schedule, forming a self-limiting mechanism.

(3) Combine "hard and soft" projects to complement one another.

Combining "hard and soft" projects primarily means mixing military product development with basic research. A product-development-oriented research institute not only must produce "hard" products but also has to generate "soft" results in order to improve its competitiveness for survival. Nevertheless, short-term economics is still seriously impacting basic research. In recent years, funds for basic research have been repeatedly cut; this is weakening basic-research teams. Many key people are leaving for development-oriented companies and are not willing to stay with basic research. Basic research is dwindling and has become the weakest link in military-industry research. A review of military equipment-development history in China tells us that basic research (such as engine mechanisms) is an important reason why the level of certain military vehicles has remained still for years. Therefore, the hardware developed, in terms of performance and quality, is falling far behind compared to developed nations. On the contrary, because of major breakthroughs in basic research, some products are being continuously developed. New generations continue to replace older ones which allows us to stay ahead of the game. Historic experience tells us that we must combine basic research with new-product development and provide appropriate funding for and have a proper attitude toward basic research. In addition, we must organize a strong team to get engaged in it. Basic research will be the lead to push product development into a new phase.

## Economic Statistics on High-Tech Development Zones in Wuhan, Shanghai, Nanjing, Tianjin, Changsha, Guilin

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[Article by Zhang Wanbin [1728 8001 2430]]

[Text] Editor's Note: In the 1988 No 5 issue of this journal, the construction and progress of some of China's new-technology development zones have been described. In the past year the Party and the State have paid attention to technology development, the national "Torch Plan" was announced and put into operation, the "prosperity through technology" movement became active in many places, and "rectification of the political order" promoted the advance of science and technology. All these activities have stimulated the rapid growth of new-technology development zones. Some of the zones have moved up one step and other new starts have gained vitality. Here we report some of the characteristics of a few development zones for public study and deliberation.

### Donghu High-Tech Development Zone in Wuhan Taking Shape

The Wuhan Donghu high-tech development zone was established in 1984. Its goal has been to attack a limited number of priority technology items and to develop on the go. Its policy has been to cooperate with industries from nearby and afar so as to make overall plans for the future industrial world. Since 1988, the Donghu high-tech zone has gradually matured and a number of new enterprises are taking root.

Today the high-tech zone has formed a team of fiber-optics workers with strong capabilities in communications and system integration. A medium-sized test plant capable of producing 8000 kilometers of optical fiber per year has been put into operation. A production plant jointly funded by the Chinese and the Dutch is under construction; when completed, it will annually produce 50,000 kilometers of optical fiber and 6000 kilometers of optical cable for an annual output value of 100 million yuan. It will be the largest fiber-optics plant in China. In order to form an industrial force, the trans-regional, trans-departmental Changjiang Optical Communications Group has been formed.

In 1989 there were nine projects in Wuhan listed in the national "Torch Plan"; five of these projects were from the high-tech development zone. Thirty two projects were listed in the municipal "Torch Plan"; 28 of those were from the high-tech zone. After the completion of these Torch Plan projects, the annual output value is expected to increase by 150 million yuan, the tax income is expected to increase by 41 million yuan, and foreign exchange created or saved is expected to increase by 25.85 million yuan. Today, most of the funding for these projects has been found and the projects are being implemented; some are already producing results. For example, the AC-80 nuclear-magnetic-resonance spectrometer made by the Spectrum Company in Wuhan has entered the phase of small-batch production. This project, listed in the municipal "Torch Plan," was based on a Chinese-made version of imported technology and was funded by a loan of 2 million yuan. It succeeded in obtaining international contracts and is expected to realize an output value this year of 14 million yuan, or a per-capita output value of 300,000 yuan.

Recently the high-tech zone approved two batches of 56 high-tech enterprises for preferred status in the zone. These enterprises belong to universities and colleges, research institutes, large enterprises, the army, civilian groups and joint ventures with foreign groups. The business areas include computers and information science, fiber-optic communications, opto-mechatronics [i.e., technology involving optically and electromechanically integrated systems], biotechnology, energy conservation, lasers, new materials, earth sciences, and applied nuclear technology. These 56 new enterprises have registered capital of 196.07 million yuan and have 1795 employees, including 902 with a college education. They have developed and produced 250 new high-tech products; the gross output value last year was 42.17 million yuan, the total income was 51.30 million yuan, the foreign exchange created was US $340,000, and the tax paid was 1.92 million yuan. This year the expected gross output value is 128.72 million yuan, the total income will be 129.72 million yuan, the foreign exchange created

or saved will be US $12.66 million, the tax turned over to government will be 5.28 million yuan, the after-tax profit will be 22.68 million yuan and the per-capita output value will be 72,000 yuan.

The high-tech zone is in the process of widening its open door. To date, the high-tech zone has ten "three-party capital" companies, with five of these companies in the area of high technology and bringing in foreign capital of about $23 million. In addition to the joint Chinese-Dutch optical-fiber/optical-cable company, there is also the Wuhan Telecommunications Equipment Company, a Chinese-U.S. joint venture funded at $4 million; this company produces state-of-the-art opto-electronic components and has captured two-thirds of the domestic market. Last year the company had a per-capita sales value of 79,000 yuan and a per-capita profit of 41,500 yuan. Imported-technology projects currently under negotiation include a Chinese-foreign joint venture to set up a production line for opto-electronic terminals, a granite production line jointly financed by the Wuhan Dida New Technology Company and Taiwanese businessmen, a China-Japan-Hong Kong joint venture to produce 50,000 fax machines per year, and a laser molded plate production facility with totally foreign capital. These projects will bring in a total of $15.30 million of foreign capital. In addition, the export potential of the high-tech zone is also great; contracts and letters of intents with foreign companies have been entered by the Guangdao ["Light Guide"] New Materials Company of Wuhan University ($7.21 million) and by Dida Changjiang Drill Company ($10 million).

The Donghu New-Technology Entrepreneurial Center has also incubated a batch of new enterprises in the high-tech zone. The original incubator area, which was about 500 square meters, has now expanded into an area of 2153 square meters, and an 18-million-yuan new-technology service building is currently under construction. The high-tech zone is focusing on the following: exploring avenues to bring in skilled people, strengthening and expanding the functions of the development zones, and exploring ways to further reform traditional industries.

**Shanghai Caohejing High-Tech Development Zone, Characterized by Joint Ventures and Outward-Looking Economy**

Based on its scientific and technological advantages, Shanghai established the Caohejing Microelectronics Industrial Zone in 1985 as its contribution to economic development. Subsequently, in order to extend high-tech towards commercialization, the industrial zone was expanded into the Caohejing New-Technology Development Zone in 1988. In 1989, the main office of the development zone joined with foreign companies in raising more than 5 million yuan to establish the Shanghai New-Technology Joint Development Company. The Shanghai municipal government has always been very supportive to the development and growth of new technology and the development zone and has given the development zone preferred treatment.

The Shanghai Caohejing New-Technology Development Zone has insisted on an outward-looking economy and a policy of joint Chinese and foreign development; this policy has already showed initial results. To date, more than 100 foreign industrialists have visited the development zone to discuss cooperation. Fourteen foreign companies have invested a total of $93.82 million in development-zone projects which have an overall funding of $191.53 million. Many of the fourteen "three-capital" enterprises are internationally known high-tech companies which have participated in the investment or supplied the total investment. These include the Shanghai Philips Semiconductor Company (with Chinese-Dutch joint funding to produce consumer-type integrated circuits), the Shanghai Beiling ["Bell Mountain"] Microelectronics Manufacturing Ltd. (with Chinese and Belgian funding to produce equipment and communications-type integrated circuits), 3M China Limited (solely American investment, for the manufacture of adhesive tapes and reflecting materials), and Shanghai Foxborough Limited (with Chinese and U. S. investments, for the manufacture of instruments, meters and computers). These companies are not only technologically advanced, but are also broader than pure commercial companies; they will become the main support of the development zone. Of the 14 companies, two more companies in addition to 3M China Limited are based on external investments only: Zhongcheng [0022 1004] Industries Ltd. (Hong Kong investment only, integrated-circuit duplicates manufacturer) and Changhua [7022 5478] Enterprises Ltd. (Taiwan investment only, a manufacturer of communications plug-in boards). Two companies have about an 80 percent foreign investment: Shanghai Daji [1129 6060] Data Processing Ltd. (Sino-Japanese joint venture, data processing and software production), and Shanghai Ruikan [3843 0170] Cable Accessories Ltd. (Sino-U.S. joint venture, cable accessories manufacturer). The remaining six companies have a more than 50 percent foreign investment. Hence, the interests of the development zone and the foreign investors are tied together for the benefit of tracking international high-tech development and for introducing new products into the international market.

The development zone is also actively collaborating with industrial and business departments in the Shanghai area and beyond to facilitate the import of new and high technologies. For example, Shanghai Jiaotong University developed a science and technology park in the development zone to commercialize the technology of computer hard-disk magnetic recording. Jiaotong University has also joined with foreign companies to establish Taiji [3141 0679] Information Products Ltd. [not affiliated with the Taiji [1132 2817] Computer Co.—JPRS] and Taian [3141 1344] Micromagnetics Company to produce high-density minidisk drives and thin-film magnetic heads. Also, the Shanghai Fiber-Optic Communications Engineering Company and the special Electronics Testing Base of the Ministry of Machine-Building

& Electronics Industry are both constructing operation in the zone. The Airborne Electronics Center of the Ministry of Aeronautics & Astronautics Industry has decided to move into the zone. The Sanguo [0005 2654] Cellular Computer Laboratory established by the Chinese scientists returned from the United States and the Canghai ["Blue Sea" 3318 3189] Optoelectronics Technology Institute established by the 1988 winner of the "Eureka" silver medal for S&T achievement are both located in the zone. Biologist Professor Zhou Guangyu [0719 0342 1342] also plans to build a Yuguang [1342 0342] Biological Products Research Institute in the zone. The main office of the development zone, the Municipal Science and Technology Entrepreneurial Company, and the Technology Development Exchange Center have jointly established a Shanghai Science and Technology Entrepreneur Service Center to cultivate, optimize, and nurture high-tech enterprises. The development zone has also devoted efforts to personnel training under the "Torch Plan" so that a team of industrialists with knowledge in technology and management can become available for the development of an export-oriented economy. This two-pronged policy will greatly speed up the development of high-tech and other businesses in the zone.

**Nanjing Pukou High-Tech Development Zone Has Taken a Practical Approach, Has Followed a Policy Based on New and High Technology, and Has Relied on Large Universities, Institutes and Plants**

The Nanjing Pukou High-Tech and New-Technology Development Zone was established one year ago. The construction planning is progressing smoothly and 40 projects of high and new technology have been approved for implementation, among them 36 industrial projects and four "incubation" projects.

Ever since the beginning of the development zone, the approach has been practical and has made use of the local advantages. Besides relying on the strong economic base of petrochemical and synthetic-fiber industries in Nanjing, attention has also been given to conservation. For example, the development zone was built only 6 kilometers from a 380-MW thermal electric power plant and the 600 MW Huaneng power plant under construction; this proximity has saved investments on energy and power transmission. The development zone was also close to the branch office of a digital fiber-optic communications network and a national trunkline microwave station; the proximity reduced the investments for telecommunications. Since the population density is high in Jiangsu province, the land occupied per person small, and high-tech industries usually do not have large bulky equipments, the buildings built in the development zone are therefore mostly multi-storied in order to reduce the encroachment on farm land. These practices were all compatible with the local situation in the province. The zone adopted a "rolling" development approach so that the resources were not spread out too thin. Measured investments were committed to a limited number of projects while at the same time the investments were recovered to improve the utilization rate of the investments. For example, investments for the first 18 projects were no more than 10 million yuan, and 8 million yuan has already been recovered.

The development-zone administration believes that research and development of high-tech, industrialization, and commercialization are three stages that should be coordinated. The main body of the development must be new-technology and high-tech industry and the main body should be supplemented by the incubation of high-tech results and the transfer of technology and services. To this end, they selected 36 industrial projects in the first two batches of 40 projects; 26 of the projects had investments of more than 1 million yuan and eight of the projects had investments above 5 million yuan. Among the four "incubation" projects, not one of them was purely commercial.

The development zone also clearly established a policy of relying heavily on large universities, large institutes and large plants [the "three main [organizations]"] in the local area. Of the 40 approved projects, 16 belonged to universities, nine belonged to large research institutes, and 15 were proposed by plants. Based on the "three main [organizations]" policy, a public-ownership system in the development of the high-tech zone was guaranteed. Among the 40 projects, 34 projects belonged to the public, two projects belonged to groups, and four projects were "three-capital" projects.

In addition, the pragmatic approach of the development zone has also evident in the optimization of the industrial structure. They decided on a policy that gave microelectronics, information, and electromechanical integration the leading role and called for active development of new materials, conservation technology, and biotechnology. Nineteen of the 40 projects were in the microelectronics and information technology area, 15 were in mechatronics [i.e., electromechanical integration], four were in new materials and two were in biotechnology. They have also increased the percentage of investments on high-tech and new-technology products, products suitable for the international market, and products that would replace imports in order to strengthen the lasting power of the national economy. Most of the 40 projects were of the investment type, and only a very few projects were of the consumer type. The products of eight of the projects can be exported and most products can be used to replace imports. Today the development zone is accelerating the pace for attracting foreign capital. Foreign companies are quite interested in the investment environment of Nanjing and have come often to visit and discuss business.

**Tianjin New-Technology Industrial Park Has a Layout of "One Point, One Line, and One Area"**

Since the establishment of the Tianjin New-Technology Industrial Park one year ago, the park has enjoyed the strong support and encouragement of the municipal

government and the State Science & Technology Commission. The central task of the start-up stage is to formulate the policy, coordinate the effort, make a good plan, establish the management system, and move forward sure-footedly.

Comrades in Tianjin summarized the layout of their industrial park as "one point, one line, and one area." "One point" refers to a research base under construction. The base occupies an area of 800 mu and consists now of 13 research institutes and more than 2700 technical personnel. With a 1.3-billion-yuan investment, a small multidisciplinary high-tech zone is being formed. Located in this zone will be a technology entrepreneur service center, one of the state's "incubator" experimental zones. With close coordination of the city planning commission and science commission, the main project and preliminary expansion designs have now been approved. The first phase of construction this year will be 5000 square meters at an investment of 2.5 million yuan. The second phase of construction will be completed during the Eighth 5-Year Plan, at which time an entrepreneur service base will be formed. The term "one line" refers to Anshanxidao Technology and Trade Street. The Technology and Trade Street, 2.6 kilometers long, is located in the northeastern part of the development zone and is surrounded by a high concentration of universities, research institutes and enterprises. The Municipal Planning Office and Nankai Zone planned the street together, with strong support of industry and the business community, the tax and finance offices and the universities. Last year, 36 new enterprises moved into it. Open for business today are 70 enterprises with registered capital of 40.28 million yuan and 1068 employees, of whom 93.2 percent are technical staff. Among the 70 businesses, 14 are run by universities, 24 are run by research institutes, 22 are run by enterprises, eight are jointly run by enterprises, universities, and institutes, and six are run by private parties. In terms of ownership, 25.7 percent are public-owned, 51.4 percent are owned by groups, 14.3 percent are jointly owned, and 8.8 percent are privately owned. The main body of the business is therefore publicly owned. The Technology and Trade Street has adhered to the policy of starting with a fixed number of projects and combining technology, industry and trade. They carefully made sure that the income from technology was the main part of the total income, and research and development of high-tech and new products were the main activity. Up to the end of July 1989, the Technology and Trade Street has developed a total of 330 projects, 222 of them completed. Fourteen of the projects were sponsored by the state, ministry or city government, 10 products have entered the international market, 16 products have met or approached international standards, and 21 products have received awards from the ministry or the city. By the end of this year [1989], 120 enterprises are expected to be located on the Street and a preliminary phase will be completed. The term "one area" refers to a 1000-t0-2000-square-meter intermediate production base in the plan. This area will accommodate 30-50 large enterprises for new and high-tech products, including internal investment and "three capital" enterprises.

The emphases of the Tianjin High-Tech Zone are new materials, biotechnology, microelectronics, and electromechanical integration. In order to improve the environment, the high-tech zone also participated in the "Torch Plan," and has attracted a number of business and companies from outside the region, including Northern Computer Company, China Software Company, Beijing Yongxin Company, Weifang Computer Company, and China University for the Mining Industry.

### Changsha High-Tech Development Experimental Zone Is Known for Its Unique Development Mode and Its Emphasis on the Operation Mechanism

Changsha established its high-tech development experimental zone one year ago. So far 66 new-technology enterprises have been approved to move into the experimental zone and 129 new products have been developed. The gross output value for the first four months of this year was 47.10 million yuan. By the end of this year, the number of enterprises in the zone is expected to exceed 80, the number of new high-tech products will reach 150 and the gross output value will exceed 100 million yuan. The experimental zone submitted 11 "Torch Plan" projects to compete in the national "Torch Cup"; two of the submissions were rated as superior items and one submission was rated as having a superior product.

The healthy growth and smooth operation of the experimental zone cannot be separated from the unique development mode, management system and operation mechanism set by the zone itself. The experiment zone abandoned the traditional development mode of "a piece of land, a wall, a pot of money, and a batch of plant buildings." Based on the actual situation in Changsha, the experimental zone adopted a policy of "use whatever is available, start right from where things are, distribute all over the place, and construct everywhere." Conservation and pragmatism became the goals to strive for. In one short year, the science park was built up by priority and quickly acquired the ability to develop new high-tech products and "incubator" functions. The approach took little investment and produced quick results. For example, Kexiang [4430 3276] Chemical Development Company, established by the Provincial Institute of Chemical Engineering, started production after making only minor modifications to its plant, and created 10 million yuan of output value in the first half of this year. The output value is expected to reach 20 million yuan by the end of the year; the speed and benefits are very obvious.

Since the management is unified while operations are dispersed, the experimental zone explored a high-efficiency management method. Ever since the beginning, they announced a management policy of "one organization, one stamp, one window." The advantages are that the organization is simplified and that overlapping and repetition are eliminated. The procedures for doing business and for approving applications are simple and efficient. Bureaucracy is reduced and management organizations are given authority. This method helps to

move gradually toward a scientific, democratic and standardized system. Experience shows that the experimental zone has benefitted from this management system in the early and middle phases of its development.

Comrades in Changsha understand clearly that the power of high-tech industry is not only in the power of science and technology, but also in the nimble operation of the mechanism. They have therefore devoted efforts to the improvement of the mechanism. In policy making, they have insisted on the separation of the two rights. The enterprises operate on the plant-manager responsibility system, or the general-manager responsibility system under the leadership of the board. Independent operation and independent policy-making have allowed the business to respond quickly in the competitive environment. In operation, they have adhered to the basis of scientific and technological development, followed the guidance of the market needs and strived for quality, efficiency, and reputation. They have aimed at opening up the domestic and foreign market with top products. In evaluating projects, they did not limit their pursuit to only high-trade products; instead, they opted for a combination of high, medium and low-grade products. In the meantime, they stressed that the value of production of new high-tech products must exceed 50 percent of the gross output value in order to satisfy the standards of the experimental zone. In terms of personnel, they supported mobility but also stressed the cohesive force of enterprises. They paid attention to material benefits but also emphasized political work and stimulation of creativity. They made efforts to development the talent and initiative of individuals but also stressed the advantages of groups and the spirit of collectiveness. In addition, they made a rational combination of the profit mechanism and the constraint mechanism of enterprises so that the mutual benefit allowed healthy growth. The management mechanisms used by the Changsha High-Tech Development Experimental Zone should be very useful references for other places.

**Guilin New-Technology Development Zone Built on the Basis of Key Industries and "Torch Plan"**

The central policy of the Guilin New-Technology Development Zone established one year ago is to "stand on key industries and move forward on selected projects." As soon as the development zone was established, 10 new high-tech items were selected as start-up items. After repeated study, experts and scholars believed that these 10 items are mature enough for development and, with relatively small investments, can bring benefits in a short term. The future prospects of these items are also good and hence they should be approved for implementation immediately. After an initial effort, an increase in output value of 24.4979 million yuan and a tax income of 3 million yuan were realized at the end of 1988; out of this, 10.3379 million yuan of output value increase and 1.143 million yuan of taxes were realized within the development zone.

Following the strategy of "paying attention to the development of high-tech industries," the development zone actively participated in the "Torch Plan." The management committee of the development zone went through more than 80 applications of new high-tech items and eight of them finally received national "Torch Plan" status, which ranked sixth in the nation. In addition, they also organized five conservation projects, three machinery-industry foundation items, and 10 new-product projects to pursue as municipal "Torch Plans." The completion rate of these projects is expected to be 1:4. After the completion of these projects, the total output value will be increased by 200 million yuan per year and tax income will be increased by 70 million yuan. By then the "Torch" will be burning bright in Guilin.

The development zone has also supported key business items that were safe, unique, and produced quick results with little investment. For example, the construction of a Guilin branch plant of the Xingan [5281 1344] Communications Equipment Plan under the Ministry of Posts & Telecommunications recently began in the zone. The major products of this plant will be high-speed fax machines, laser typesetters, small microwave transmitter/receivers, and uninterrupted power supplies. Once the plant is completed, a system of compatible office-automation and information-technology products will be produced. This will be beneficial to bringing along other industries and modulating the industrial structure of Guilin.

In order to break new ground, the development zone is in the process of negotiating with foreign investors regarding cooperation on various items. To date, countries contacted regarding several dozen projects include the United States, Japan, Canada, Great Britain, France, Spain, the FRG, Singapore, and Thailand. In addition, Hong Kong and Taiwan have also been contacted. More than ten projects have reached intent agreements and eight items have had formal agreements; the prospects for joint ventures are very good. Moreover, the development zone is also actively seeking out sister organizations in China and abroad and has interacted with the International Association of Science and Technology Parks. With the consent of the Science Committee of the Province of Guangxi, the development zone has applied and joined the Association. On the domestic front, the Guilin Development Zone has established a relationship with high-tech zones that started earlier, including the Beijing New Technology Industrial Development and Experimental Zone and the Wuhan Donghu New Technology Development Zone. Through exchange of experience, entrepreneurial experience and management methods of others may be adapted, and lateral cooperation may be developed. These are undoubtedly beneficial to the construction and growth of the development zone.

## Diffusion Bonding of SiC Whisker-Reinforced Aluminum Composites

*40100038A Harbin HARBIN GONGYE DAXUE XUEBAO [JOURNAL OF HARBIN INSTITUTE OF TECHNOLOGY] in English No 1, Feb 90 pp 126-128*

[Article by Wang Guoqing, Niu Jitai, and Zhao Feng; received date: 20 Oct 89]

[Text] Key words: Composites, diffusion bonding

SiC whisker reinforced aluminium composites ($SiC_w$/Al) are one of the most promising materials, known for high stiffness-to-density and high strength to density. In order to find extensive use in the aerospace industry and other areas, it is necessary to develop the techniques for joining it. Up till now, little research has been made at home and only a few projects abroad.

The study of joining aluminium matrix composite materials shows that their weldability is poor, for should general welding processes press and heat the joint, it will produce harmful effects: heat makes a chemical reaction between the whisker and matrix metal to form brittle compounds which will reduce the interfacial strength. Furthermore, pressure will deform the matrix metal and cause damage to the whiskers. For example, fusion welding of $SiC_w$/Al produces a molten pool that has pool fluidity and that solidifies with large volumes of porosity in both the weld and the heat-affected zone. Furthermore, if welding temperatures are above the liquidus of the aluminium alloy, this results in the formation of brittle aluminium-carbon compounds AL4C3 by the reaction:

$$4AL(1) + 3SiC(s) = AL4C3(s) + 3Si(s) \quad (1)$$

Since fusion welding of SiC/AL composites has so many disadvantages, a few attempts have been made to bond it with diffusion bonding as a solid-state technique which can be achieved at low temperature and low pressure.

The $SiC_w$/6061AL composite material used in our investigation was made by the Metal Material Division of HIT using the method of molten metal squeeze-infiltration. The whisker volume percentage is approximately 20 percent, and the matrix metal is 6061Al alloy (Al-0.6Si-1.0Mg-0.25Cu). The typical mechanical properties of it compared with 6061Al are summarized in Table 1.

**Table 1. Typical Mechanical Properties of 20 Percent $SiC_w$AL Compared With 6061AL Alloy**

| | $SiC_w$/AL6061 | 6061AL |
|---|---|---|
| UTS MPa | 375 | 320 |
| ys MPa | 330 | 280 |
| Tensile modulus GPa | 120 | 72 |
| Poisson's ratio | 0.33 | 0.33 |

Diffusion bonding experiments were performed using a Gleeble-1500 thermal simulation machine. The sample is shown in Figure 1. A butt-joint construction was adopted. The surface to be bonded was polished with

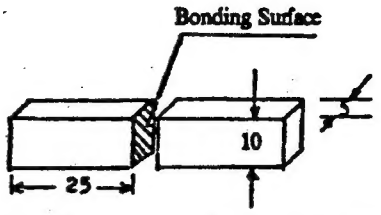



**Figure 1. Diffusion Bonding Specimen and Its Size**

No. 800 abrasive paper and then was cleaned and etched to remove surface contamination and excessive oxide films. In order to get satisfactory joints, the specimen was bonded with the aid of an intermediate layer, which is listed in Table 2. The bonding temperature is far below the melting temperature of 6061Al alloy, and the bonding pressure is so low that no macro deformation has been made. All the bonding was carried out in a vacuum of $1x10^{-2}$ torr. The tensile specimens were cut from the joints and then inserted into an electromechanical universal material-testing machine.

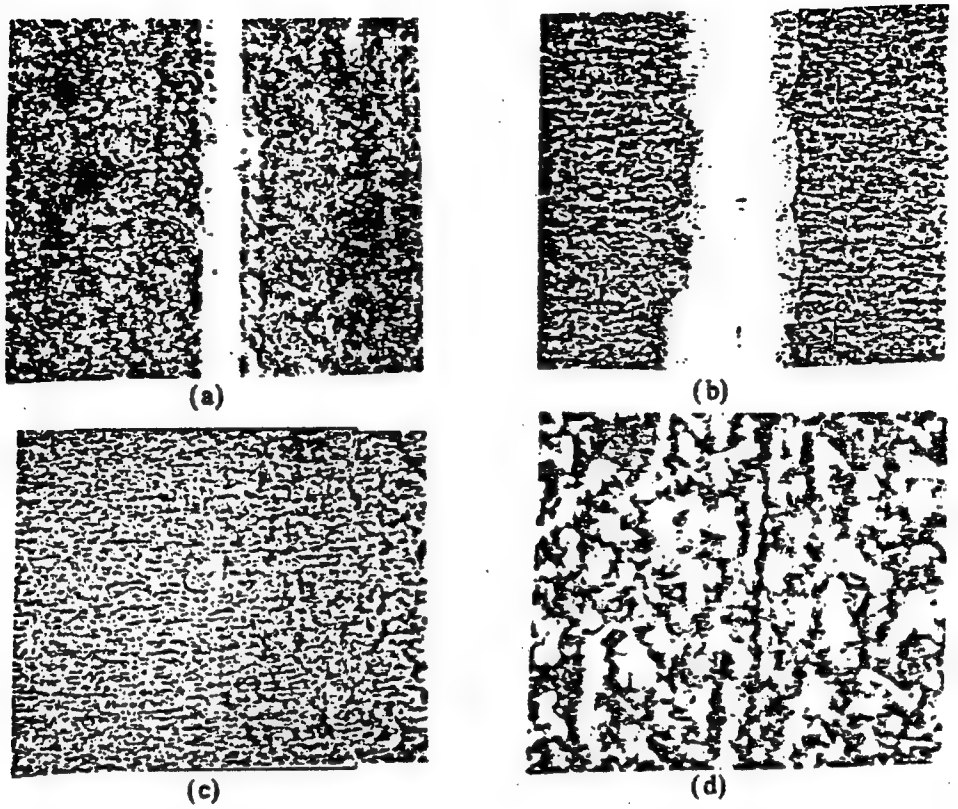
**Table 2. Parameters for Diffusion Bonding of $SiC_w$6061AL Composite Material**

| Foil | AL | Ni | Cu | Ag | No |
|---|---|---|---|---|---|
| Bond. Temp. K | 823 | 853 | 803 | 823 | 853 |
| Bond. Pres. MPa | 8 | 12 | 6 | 12 | 15 |
| Bond. Time (min) | 30 | 20 | 15 | 20 | 30 |

Observations by electron probe microanalysis (EPMA) and scanning electron microscopy (SEM) were carried out across the interfaces and partly on the fracture surface.

Figure 2 shows the microstructures of cross-sections of joints bonded with Ni foil (a), Cu foil (b), Al foil (c), and no foil (d). All the joints excepting (d) were bonded intimately and atomic mobilities have been sufficient enough to form a diffusion layer of foil metal. Without the aid of the intermediate layer, many unbonded regions were recognized, as seen in Figure 2 (d). Although parameters have been adjusted, little improvement was observed. This is because the SiC whisker hinders the diffusion of aluminium and $SiC_w$6061Al composites have such a bad plastic deformability that it is not easy to contact them intimately. Since nickel has the same crystal structure and similar atomic radius (Ral = 1.42 angstroms, Rni = 1.25 angstroms) with aluminium, the diffusion layer is wider than others. The wettability of the SiC whisker to aluminium can be improved by copper for the same reason as nickel above; satisfactory bonded joints were obtained when Cu was selected as an intermediate layer as seen in Figure 2 (b).

Since the joints were bonded below the Cu-Al eutectic temperature, no reaction products could be recognized by X-ray diffraction analysis. Figure 3 shows the tensile strength of joints bonded with the aid of various metal




(a) Ni Foil 10μm Thick (b) Cu Foil 30μm Thick (c) Al Foil 7μm Thick (d) No foil

**Figure 2. The Microstructures of Joints Bonded With Foil or No Foil**

foils. It is apparent that the average strength of the joints is far below that of base metal. The joints bonded with the aid of Ag foil have the highest strength comparatively.

From our experiments, we find that it is possible to get satisfactory joints by the method of diffusion bonding with the aid of metal foils. We will continue to study ways to raise the joint strength and report the progress of our work.

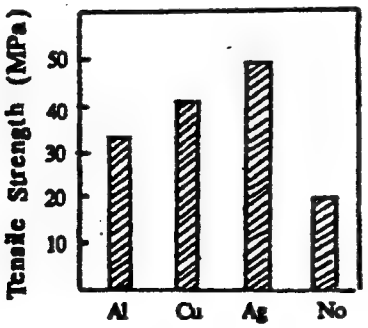



**Figure 3. Tensile Strength of Joints Bonded With Various Foil**

## Electrical Characteristics of InSb Crystals Grown in Microgravity, Ultragravity Environments

*90CF0206A Beijing KEXUE TONGBAO in Chinese Vol 34 No 19, 16-31 Oct 89 pp 1466-1469 [MS Received 17 Jun 89]*

[Article by Zhang Fangqing [1728 0119 3237], Zhang Nanping [1728 0589 5493] and Chen Guanghua [7115 0342 5478] of the Physics Department, Lanzhou University; Zhang Li [1728 5461] of Northwest Teachers' College, and Ma Wenju [7456 2429 7467] of the Institute of Mechanics of the Chinese Academy of Science: "Study of Electrical Characteristics of InSb Crystals Grown in Microgravity and Ultragravity Environments"]

[Text] Key Words: Microgravity, Ultragravity, Convection.

### I. Introduction

In recent years, a great deal of interest has been focussed on crystal growth under microgravity in space.[1-3] Under microgravity in space, because natural convection due to gravity, buoyant force in fluids and separation of materials due to density difference virtually do not exist, it is possible to keep matter mixed or under suspension. In this case, diffusion becomes the main factor and a liquid

is bound by its surface tension. However, microgravity physics is still in a development stage. Many phenomena cannot be explained. The real physical picture for convection is unclear. In addition to studying space physics, physical effects in material processing and material performance characteristic, environments have been designed and constructed to simulate microgravity and ultragravity in order to study gravity-related effects. Muller[4] et al. used a centrifuge to accelerate a crystal-growth furnace in order to apply a force greater than $g_o$ ($g_o$ is the gravitational acceleration) to the melt to study the convection inside the melt during the growth process under an equivalent ultragravity condition. This paper reports the electrical characteristics of InSb crystals grown under a variety of gravity conditions and discusses the effect of gravity on material characteristics.

## II. Experiment

The InSb specimens used in this work were prepared by the normal directional solidification method involving remelting and recrystallization. First, a Zn-doped (approximately $10^{16}/cm^3$) InSb crystal grown in the <111> direction was cut into several 50-mm-long rectangular rods. Each rod was individually placed in a clean quartz tube and sealed in $1.33 \times 10^{-3}$ Pa vacuum. These sealed quartz vials were used in remelting and recrystallization experiments under various gravity conditions.

The microgravity condition was achieved on a recoverable satellite launched by China on August 5, 1987.[5] The level of microgravity was estimated to be lower than $2 \times 10^{-4}$ $g_o$, i.e., the specimen was prepared at $2 \times 10^{-4}$ $g_o$. The 1 $g_o$ condition is defined as the remelting and recrystallization experiment carried out on the ground in the very furnace that was going to be loaded on the satellite using a temperature gradient close to that to be used on the satellite. The ultragravity condition was created by accelerating the crystal growth furnace with a centrifuge to simulate such environment. During the growth period, the centrifuge first rotates at 22 r/min (revolutions per minute); at this rate, the centrifugal force exerted on the melt is 3 $g_o$. Then, the speed of the centrifuge is raised to 31 r/min; at this rate, the specimen is under 6 $g_o$. The specimen was heated for 90 minutes at 3 and 6 $g_o$ with temperature gradients similar to that at 1 $g_o$. During this period, the axis of the furnace and temperature gradient are parallel to the centrifugal force. For ease of discussion, any force greater than 1 $g_o$ is considered ultragravity. Thus, four specimens were prepared at $2 \times 10^{-4}$, 1, 3 and 6 $g_o$, respectively. They were then sliced into 1-mm-thick pieces at comparable places. Ohmic contacts were made for testing of their electrical characteristics.

Electrical parameters, primarily the Hall coefficient $R_H$ and resistivity $\rho$, were measured as a function of temperature using the Van Der Pauw method over a temperature range from 80 to 400 K. A JEM-1200ES transmission electron microscope was used to examine every specimen and provide energy-spectrum analysis. A metallurgical microscope was used to observe dislocations and defects in these specimens.

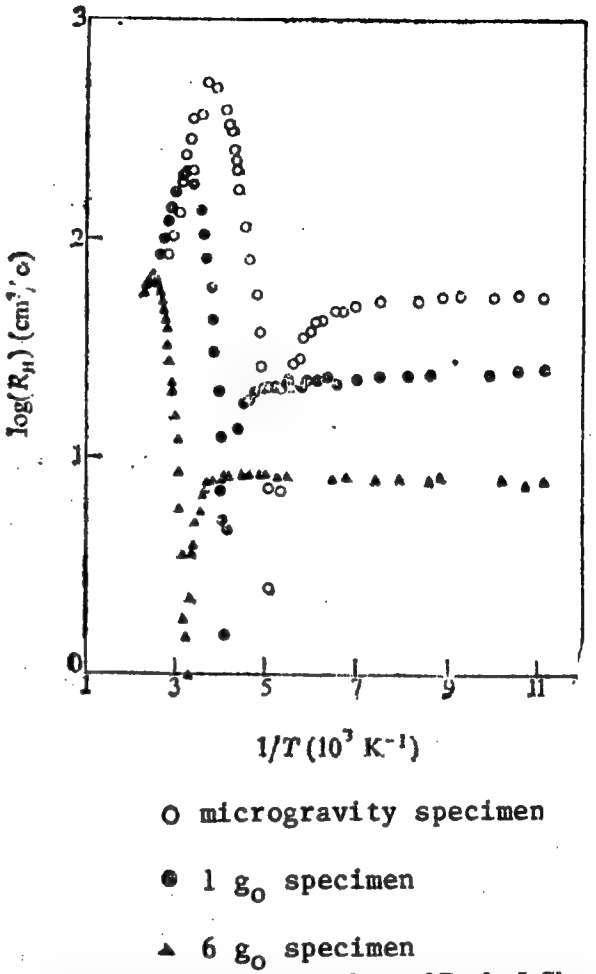



**Figure 1. Temperature Dependence of $R_H$ for InSb Specimens Prepared in Various Gravity Environments**

## III. Results and Discussion

Figure 1 shows the temperature dependence of the Hall coefficient $R_H$ for InSb specimens prepared under microgravity and at 1 and 6 $g_o$. At a low temperature, $R_H$ is positive, indicating hole conduction. As temperature rose, $R_H$ turned from positive to negative and signs began to change at 198, 248 and 308 K, respectively. The specimens went from impurity excitation into intrinsic excitation. Since electron mobility is much greater than hole mobility, electronic conduction is the primary effect. The Hall coefficient sign-change temperature $T_R$ goes up with increasing gravity, as shown in Figure 2. This result indicates that preparation of specimens in ultragravity causes new defect states. These defects act as impurities and impurity conduction is increased. Thus, the temperature to reach intrinsic excitation rises. Hence, the higher the gravity is during preparation, the lower the absolute value of $R_H$ will be, just like what we see in Figure 1 where the specimen prepared at 6 $g_o$ has the lowest $R_H$.

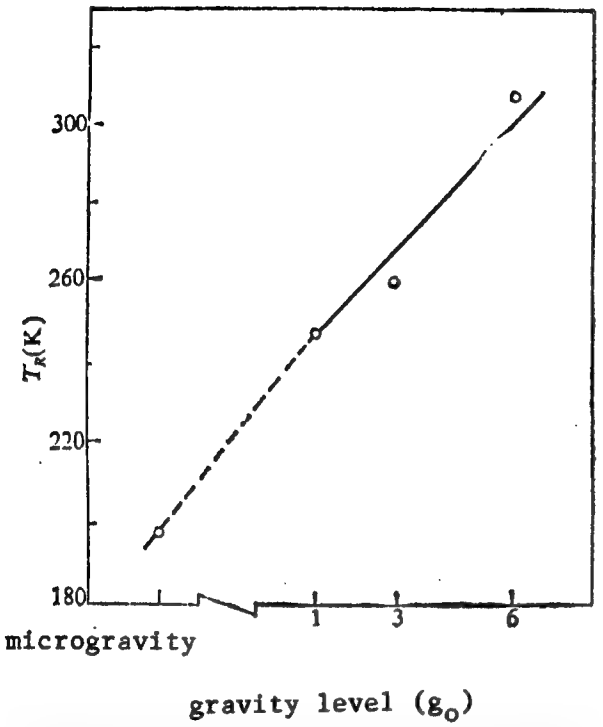



**Figure 2. Hall Coefficient Sign-Change Temperature $T_R$ vs. Environmental Gravity g During Preparation**

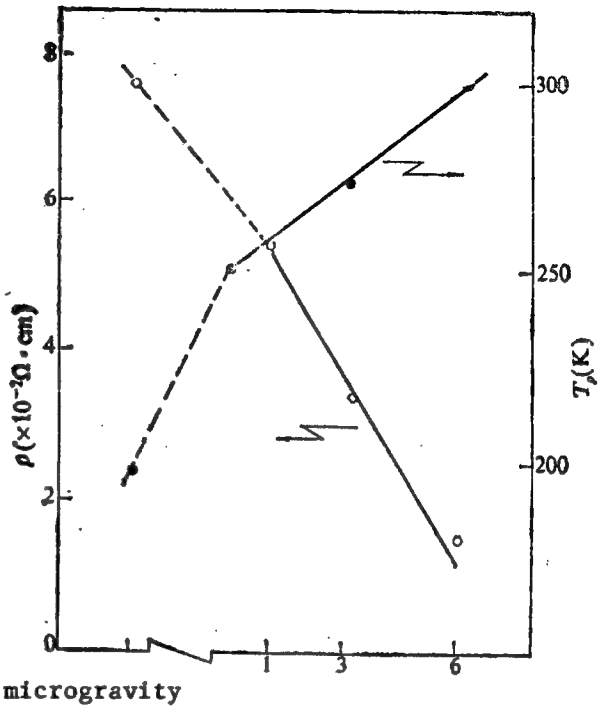



**Figure 3. Dependence of ρ (150 K) and $T_\rho$ Upon Gravity g**

We also measured the resistivity ρ of each specimen prepared under different gravity conditions as a function of temperature. At low temperatures, the resistivity ρ of the microgravity specimen increases with rising temperature. There is not too much change for the ground and 3 $g_o$ specimens. The ρ of the 6 $g_o$ specimen drops slightly as temperature increases. In the intermediate temperature range, resistivity goes up, reaches a maximum and declines rapidly with increasing temperature for all specimens. The maximum resistivity temperatures, $T_\rho$, for specimens prepared in microgravity, 1, 3, and 6 $g_o$ are 200, 250, 270 and 300 K, respectively. At the same temperature, the higher the gravity is the lower the resistivity becomes, as shown in Figure 3. Figure 3 shows resistivity values of all specimens at 150 K.

Based on $\mu_H = \sigma R_H$, we calculated Hall mobility $\mu_H$. From the results of $R_H$ and ρ obtained, all specimens could be considered in the saturated-impurity-conduction zone at 150 K. Over this temperature range, the measured value is hole mobility. At above 310 K, they could be considered in the intrinsic-conduction zone. Since electron mobility is much larger than hole mobility for InSb, it is reasonable to think electronic conduction is the primary mode. Thus, the mobility measured is electron mobility. We calculated Hall mobilities for these specimens at 100 and 350 K and the results are shown in Figure 4. Figure 4 shows that for the same specimen, electron mobility at high temperature is always much larger than hole mobility at low temperature. At the same temperature, both electron mobility and hole mobility decrease with increasing gravitational acceleration during crystal growth. The specimen prepared under microgravity has the highest mobility, indicating the specimen has the least impurity level and defects.

Based on the results presented above, the specimen grown in microgravity has the best electrical characteristics and specimens grown in ultragravity have poor electrical properties. In order to explain the effect of gravity on material characteristics from a structure point of view, we used a metallurgical microscope to examine the dislocations and etched pits of specimens prepared in different gravity environments. Specimens prepared in ultragravity have significantly more etched pits, while the specimen grown in microgravity has fewer dislocations and etched pits. In addition, a transmission electron microscope was used to perform energy-spectrum analysis on every specimen in order to determine the extent of atomic segregation at 10 different spots inside each specimen. It was found that there are more In atoms than Sb atoms in all specimens. Table 1 lists the average degrees of atomic segregation for these specimens. It shows that the degree of atomic segregation in the specimen prepared at 6 $g_o$ is seven times higher than that prepared in microgravity. This indicates that the stoichiometry of the specimen grown in microgravity is closer to its theoretical value. Specimens grown in ultragravity cause the segregation of In atoms which leads to the formation of negatively charged centers. These

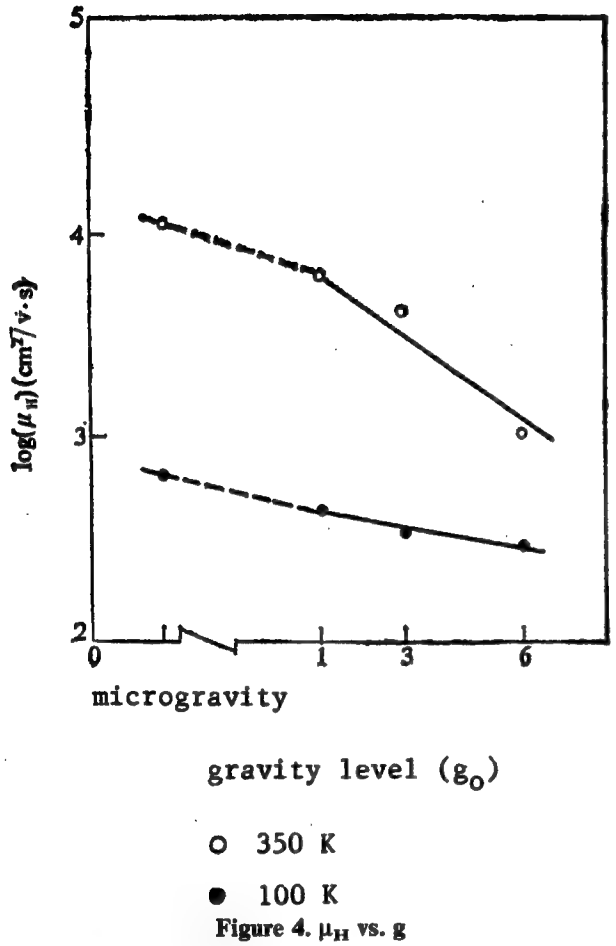



**Figure 4. $\mu_H$ vs. g**

negatively charged centers in InSb act as impurity centers which drive electrical conductivity up, resistivity down, and the Hall coefficient down. Due to an increasing number of scatter centers, Hall mobility also decreases. Because of increasing defect and impurity levels, the transition temperature from impurity excitation to intrinsic excitation also rises.

**Table 1. Mean Atomic Segregation of Specimens Grown Under Different Conditions**

| Gravity During Growth | Microgravity | 1 $g_o$ | 3 $g_o$ | 6 $g_o$ |
|---|---|---|---|---|
| Atomic Segregation | 0.16% | 0.44% | 0.75% | 1.2% |

The effect of gravity on crystal growth is actually the effect of gravity on convection in the melt. In microgravity, convection inside the melt is very slow and stable. The streamline is parallel to the surface of the melt.[6] Therefore, the sample has a uniform growth rate and homogeneous composition. The degree of atomic segregation is very small for compounds with more than two elements. The crystal structure is also relatively perfect. When a crystal is grown on Earth under 1 $g_o$, natural convection exists in the melt due to gravity which produces a periodic oscillation that makes the temperature at the solid and liquid interface fluctuate.[7] Thus, the growth rate is affected and impurity distribution is uneven and impurity fringe becomes visible.[8] However, when an ultragravity condition is achieved by a centrifuge, the melt is not only subject to a centrifugal force parallel to the temperature gradient but also to gravity perpendicular to the temperature gradient. These two forces complicate the convection inside the melt. The presence of turbulence and eddies is possible. The periodic oscillation associated with convection gradually disappears. Because the temperature gradient is not lined up with the direction of convection, the crystal growth rate is unstable and impurity distribution uneven. There are more defects. The crystal is less perfect, resulting in inferior electrical characteristics. Nevertheless, Muller et al., claimed that impurity fringes could be eliminated by increasing acceleration in crystal growth and obtained the same results as those for microgravity. We have not yet seen this effect. This issue is yet to be further investigated.

Acknowledgment: The microgravity condition was made possible by the [Chinese] Academy of Space Technology [previously translated as Research Institute of Space Technology] and by Institute 510. The ultragravity environments were completed with assistance from the CAS Institute of Mechanics. This work was also supported by Zhou Bojun [0719 0130 7486]. The authors wish to express their gratitude to those mentioned above.

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## Isolation, Characterization of Restriction Endonucleases BstF I, BstS I From *Bacillus Stearothermophilus*

*40091008a Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 361-366*

[English abstract of article by Chen Zhongfu [7115 0022 1318], Kong Huimin [1313 1979 2404], et al., of the Institute of Genetics]

[Text] Two type II restriction endonucleases, BstF I and BstS I, have been isolated from *Bacillus stearothermophilus* FH58 and *Bacillus stearothermophilus* S183. The recognition sequence and cleavage site of BstF I is A/AGCTT, and C/PyCGPuG in BstS I. Therefore, BstF I is the isoschizomer of Hind III, while BstS I is the isoschizomer of Ava I. These two enzymes can be purified easily with heparinagarose. A total of 10,000 units of BstF I and 24,000 units of BstS I can be purified per gram wet cell of FH58 or S183, respectively. They have different thermostabilities. BstF I and BstS I are stable under incubation at 45°C for a long as 6 hours. After 1 hour incubation at 50°C, the relative activity of BstF I was reduced by 50 percent, whereas the relative activity of BstS I was reduced by only 10 percent after 1 hour incubation at 70°C.

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## Establishment, Identification of Complete Human/Rodent Hybrid Cell Clone Panel

*40091008b Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 367-374*

[English abstract of article by Xue Jinglun [5641 0079 0243], Qiu Xingfang [6726 0207 5364], et al., of the Institute of Genetics]

[Text] A combination of chromosome G-banding, Giemsa-11 differential staining and chromosomal marker isozyme analysis is used to establish and identify a complete human/rodent hybrid cell clone panel. This panel consists of 10 clones, which can be used in mapping genes on the 24 different chromosomes. The deleted chromosome Nos 3 and 7 have been combined with other deleted chromosomes, and it is possible to map the genes on chromosomes 3, 4, 5, 7 and 8 regionally.

This project was supported by the National Natural Science Foundation of China.

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## Chemical Synthesis of Oligonucleotides

*40091008c Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 375-379*

[English abstract of article by Gao Bifeng [7559 1801 1496], Min Yongjie [7036 3057 3381], et al., of the Institute of Genetics]

[Text] This paper describes the preparation of four fully protected deoxynucleoside phosphoramidites and the synthesis of oligodeoxynucleotides on a solid support. A total of 22 oligodeoxynucleotides were synthesized.

**Table 1. Sequences of Oligonucleotide Fragments and Synthesis Production Rates**

| Product Number | Base Number | Sequence | Harvest Rate | Average Production Rate |
|---|---|---|---|---|
| 1 | 49 | AGAGATCAGGTCACGCGGACGCAGATGGAA-GTTTTTAGACTGAGCCAGG | 57.3 | 98.8 |
| 2 | 43 | ACTTGTCCAAGGCTTCGATGTGCATACAAA-CAAAGTCGTGCAA | 50.1 | 98.3 |
| 3 | 43 | ACTTGTCCAAGGCTTCGATGTACATACAAA-CACCGTCGTGCAA | 58.7 | 98.7 |
| 4 | 44 | AAAGATGTCAATACAGAGACTTGAAGTGGT-GGGAATTGAGATCA | 55.9 | 98.6 |
| 5 | 39 | AGCTTGATCTCAATTCCCACCACTTCAAGTC-TCTGTATT | 51.1 | 98.2 |
| 6 | 42 | GTGCCTTGAAGAAGAACTGAAACCGCTA-GAA-GAAGTCCTGAA | 50.4 | 98.3 |
| 7 | 39 | AGCTTGGAACTCCGACTCCGAATGTCCAT-TGTCCCACGA | 60.1 | 98.6 |
| 8 | 42 | AACCTGCTGTCTGCGATCAAATCTCCGTGC-CAGCGTGAAACC | 34.9 | 97.4 |
| 9 | 45 | CGTCTGTCTGCTGAAATCAACCGTCCAGAC-TACCTTGACTTCGCT | 36.8 | 97.7 |
| 10 | 40 | AGCTTGGATCCTCACAGAGCGATAATACCG-AAGTATACCT | 36.7 | 97.4 |
| 11 | 42 | GACCAGATTCAGCGAAGTCAAGGTAGTCTG-GACGGTTGATTT | 36.3 | 97.5 |
| 12 | 47 | TCAGGGTAGAGATGATAGACTGAGAGAAG-GTGATCCAACGGTTCAGG | 50.7 | 98.5 |
| 13 | 41 | GGACAAGTACGCTTGTAACTGTGTTGTTGTT-TACATCGGTT | 67.3 | 99.0 |
| 14 | 39 | GATCCTGAAAAACTGGAAAGAAGAATCTGA-CCGTAAAAT | 36.3 | 97.3 |
| 15 | 38 | GTTCAAAAACTTTAAAGATGATCAGTCTATC-CAGAAAT | 48.3 | 98.0 |
| 16 | 39 | TTTTCAACTCTAACAAGAAGAAACGTGAC-GACTTCGAAA | 55.1 | 98.4 |
| 17 | 37 | AGCTTTTCGAAGTCGTCACGTTTCTTCTTGT-TAGAGT | 37.0 | 97.2 |
| 18 | 41 | GGCTGAACTGTCTCCCGCGGCTAAAACTGG-TAAACGTAAAA | 53.3 | 98.4 |
| 19 | 49 | GATCCTCAGTTTTAGCTTCCTTCAACAACT-TCTTTTTTTTCTTTCAGGT | 57.1 | 98.8 |
| 20 | 33 | AATTCATGCTGACGCTGCTGTTGACACA-TCCTT | 53.2 | 98.0 |
| 21 | 38 | GATGTTTCAGTTCGGTAGCTTTTTTCGGCAT-GTAGAAT | 59.4 | 98.6 |
| 22 | 33 | GTGCCTTGAAGAAGAACTGAAACCGC-TAGAAGA | 66.7 | 98.7 |

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## Isolation, Characterization of Human X Chromosome DNA Segments

*40091008d Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 380-385*

[English abstract of article by Zhang Dongmei [1728 0392 2734], Qin Shizhen [4440 0013 4176], et al., of the Institute of Genetics]

[Text] Random single-copy DNA segments were isolated from the Los Alamos human X chromosome library. The library was screened three times for nonrepetitive DNA inserts by plaque *in situ* hybridization to total human and mouse DNA. Out of 100 plaque forming units (pfu), one to two single-copy recombinants were obtained. DNAs from clones containing single-copy inserts were labeled by nick translation and Southern hybridization to normal human and mouse DNA, and to a panel of cell hybrid DNAs either retaining or not retaining the X chromosome. The human single-copy DNA segments isolated were all localized on the X chromosome. Three segments, i.e., DXFD 52, DXFD 73, DXFD 75, were mapped to the X chromosome. These segments will be precisely localized to regions on the X chromosome by *in situ* chromosomal hybridization.

This project was supported by the National Natural Science Foundation of China.

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## Molecular Cloning, Expression of *Bacillus Subtilis* β-1,3-1,4-Glucanase Gene in Escherichia Coli

*40091008e Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 386-392*

[English abstract of article by Song Daxin [1345 1129 2450], Zhang Shengmei [1728 0524 1188], et al., of the Department of Microbiology and Microbial Technology]

[Text] A *Bacillus subtilis* gene (bgl) coding for a β-1,3-1,4-glucanase has been transferred to *Escherichia coli* by the shot gun method using the plasmid vector pBR325. The gene is contained within a 7.1 kb EcoR I fragment and directs the synthesis in *E. coli* of a β-1,3-1,4-glucanase which specifically degrades barley glucan. The recombinant strain of *E. coli* carrying a pBR325 bgl hybrid plasmid (pFG1) is more stable without any selective pressure.

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## Conformation of Compact Type of pUB110 DNA Molecule

*40091008f Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 402-407*

[English abstract of article by Yang Shuqing [2799 2885 7230], Jiang Xingjuan [3068 5887 1227], et al., of the Institute of Genetics]

[Text] By using the alkaline lysis method, the plasmid pUB110 of *Bacillus subtilis* BD366 pretreated with an unsaturated fatty acid from duck serum was found in three conformation types, consisting of SC, OC and the dominant compact type (CT). The CT molecules migrated faster than the SC molecules during electrophoresis and appeared as compact masses under the electronmicroscope. pUB110 DNA with SC and OC conformations could be cut by the restriction endonucleases EcoR I, BamH I and Bgl II at a single site, and by Sau 3AI at multiple sites, whereas pUB110 DNA with the CT conformation was resistant to EcoR I, BamH I, Bgl II and Sau 3AI. However, after treatment at 86°C or in boiling water, CT could be digested with Sau 3AI, and the fragments produced were the same as those of the SC

and OC molecules digested with the same enzyme without treatment. It is suggested that the CT conformation be the original type of plasmid, and that the switch be made to the SC or OC forms under certain conditions.

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## Study of Relationship Between c-AMP Quantity, Amount of Toxin in Several Strains of *Vibria Cholerae*

*40091008g Shanghai FUDAN XUEBAO [JOURNAL OF FUDAN UNIVERSITY—NATURAL SCIENCE] in Chinese Vol 28 No 4, Dec 89 pp 420-425*

[English abstract of article by Dai Xianmin [2071 8300 2404] and Hong Limin [3163 7812 3046] of the Department of Environment and Resource Biology]

[Text] This paper reports the c-AMP quantity determined in four strains of *Vibrio cholerae* by radioimmunoassay (RIA) and the toxins prepared. The quantity of cholerae toxins was measured using Chinese hamster ovary (CHO) cells. The results indicate that the c-AMP quantity in *V. cholerae* is proportional to the toxin quantity produced by *V. cholerae.*

This project was supported by the National Natural Science Foundation of China.

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## Biotechnology Application in Agriculture Reviewed

*90CF0100A Beijing XIANDAIHUA [MODERNIZATION] in Chinese Vol 11 No 9, Sep 89 pp 30-33*

[Article by Yue Shaoxian [1471 4801 0341]: "The Application of Biotechnology in China's Agricultural Production"]

[Text] At present, China's agriculture faces a grave problem. Cultivated land is shrinking annually (at a rate of 5,000,000 mu per year), and the population is increasing quickly (at a rate of 15,000,000 per year). At this rate of increase and decrease, a food shortage will be inevitable. As the standard of living rises, people will also demand an adjustment in the composition of their diet—an increase in the quantity of milk, meat, eggs and other animal products as well as leguminous products in order to increase the quality of their food. This will put even heavier demands on the agricultural production of plant and animal produce to alleviate the above-mentioned problem.

Biotechnology brings hope. Practice shows that biotechnology is an effective way to increase agricultural production. It brings new hope in solving the food-shortage problem.

Biotechnology is a high-level technology. It includes four main areas: gene engineering, cell engineering, yeast engineering and fermentation engineering. The disciplines involved include molecular biology, molecular genetics, biochemistry and physiology. At present, main advances have been made in agricultural biotechnology in China and elsewhere. Many floral cultivated strains have been developed. Many plant genes have been isolated. These genes when introduced into rice, soybeans, maize, and cotton have produced many gene-transferred strains. Because biotechnology possesses immense potential, many countries in the world have been paying great attention to it. The European Community countries have jointly established a mid-to-long range "Eureka" biotechnology plan. The United States, Japan, Australia, Brazil, India, among other countries, have implemented similar plans. They have invested heavily and organized substantial scientific and technological research forces in plans to face this challenge of human survival. A foreign scholar put it this way: "If we do not understand the power of this technology, agricultural advances will be delayed." China has also expediently established the "863" high-tech development plan, and biotechnology has been listed as a highest priority area of development. Agricultural biotechnology in turn is one of its important components.

As early as the early seventies, China had already begun agricultural biotechnology research. The main focus was plant tissue culturing; the main goal was to improve strain quality. Later, gene engineering, molecular biology and animal husbandry biotechnology research were carried out in some units. This also led to widespread attention from other departments. At present, China has achieved many important advances in the above areas which have contributed to agricultural production.

Agricultural products are being improved. In the past few decades, hybridizing strains to improve agricultural products has produced significant contributions. For example, the cultivation of short-stalk rice strains and the propagation of hybrid rice strains has caused the productivity of rice to rise significantly, thus generating great economic benefits. However, in this application process, there have been problems in the regular cultivation of the strains. For example, the cultivation cycles of the strains have been long. Some crops become increasingly weak because of genetic limitations. This indicates that strains with distant genetic content should be crossed in the search for advantageous characteristics. However, strains distant genetically may not hybridize harmoniously. At the same time, it has been difficult to cultivate strains with distinct phylogenetic direction. The employment of modern cell engineering techniques and DNA recombination techniques will provide new avenues for solving the above-mentioned problems.

Cultivation of pollen and haploid bodies: After in vivo cultivation of the crops, pollen from the first- or second-generation strains were cultivated in vitro to obtain haploid strains. Then homozygotic diploid strains were obtained from chromosomal mitosis. Since the characteristics of these strains are relatively stable and they do not further divide, the cultivation cycle is greatly shortened. At present, there are more than 200 strains of plants in the world that have produced regenerated strains from pollen cultivation. Of these, China was first to cultivate more than 40 kinds, such as rice, barley, maize, soybeans, tobacco, beet, rape, large Chinese cabbage, tomatoes, apples, peaches, rubber, and poplar haploid strains. Also cultivated were barley, rice, tobacco and other plants producing many high-quality new strains. The annual propagation area has been approximately 650,000 hectares, including 350,000 hectares of rice and 240,000 hectares of barley. The Institute of Crop Research of the Academy of Agricultural Sciences produced through the cultivation of pollen two strains of unglutinoud rice—Zhonghua number 8 and Zhonghua number 9. These strains possess the following characteristics: high yield, high quality, and resiliency against rice blast. The cumulative propagation area over 6 years is 600,000 hectares. The Beijing Municipality Institute of Agricultural Sciences has produced Jinghua number 1, a new strain of winter barley. Its characteristics include high quality, high yield, and resiliency against stripe rust, leaf rust, powdery mildew, and resiliency against dry hot winds. The propagation area in 1984 exceeded 65,000 hectares.

Quick propagation of cultivated biological tissues: The technology that employs in vitro cultivation of parts of plants, such as the roots, stems, leaves, flowers, fruits, cotyledons, blastostyles, ovules, and young embryos and induces cells and tissues of these organs to produce plants is called rapid propagation. Because the coefficient of propagation is high, propagation of quality strains or seedlings can be accelerated to reap economic benefits. Also, because the points of growth do not contain viruses, cultivation of the meristem produces virus-free specimens, thus preventing the degeneration of the variety and increasing its productivity. At present, China already has successfully developed more than 100 plants using rapid propagation. Among these plants, those propagated for general use include potatoes, sugar cane, triploid seedless watermelons, grapes, strawberries, the hill haw, chrysanthemums, peonies, and orchids. Potatoes are cultivated on about 3,300,000 hectares in China, poison-free seedling cultivation area is at about 300,000 hectares, about 10 percent of the total. Regarding the cultivation of poison-free potato seedlings in some areas in the provinces of Heilongjiang, Inner Mongolia, Liaoning, and Gansu, propagation systems have been set up. In general, production can multiply to one or two times more than the current production level. This has important implications for the degeneration of the potato plant. Recently, the Kunming Botanical Institute of the Chinese Academy of Sciences was successful

in propagating the vanilla seedlings using a tissue cultivation method. The vanilla bean is a well-known natural food flavoring. This plant has a promising future in China's Fujian, Guangdong, Yunnan, Hainan and other provinces. Through generating cell embryos and embedding them in a nutritious and protective artificial seed coat, the process in effect produces an "artificial seed." This approach has a promising future. At present, successfully produced artificial seeds in China and overseas include alfalfa, celery, and turnip. The first two were produced by American botanical genetics companies, while the last was produced first in China. Artificial seeds can be used in some stages of a farm-produce seed breeding plan. For example, in the propagation of special parent plant material, seed breeding can be accelerated, and some problems not managed by ordinary procedures in seed breeding can be solved.

Mobile embryo cultivation: Cross-breeding and cultivation of young embryos and test-tube fertilization can be used to solve problems of compatability in distant hybridization. At present, interspecific hybridization of barley and wheat, wheat and barley, cultivated cotton and wild cotton, large Chinese cabbage, cabbage and intergeneric hybridization of turnip and large Chinese cabbage are being carried out in China.

Protoplast cultivation: Plant protoplasts can be an ideal recipient system for gene transfer; cell fusion can overcome incompatibilities in distant hybridization and result in cell hybrids. Up to now, protoplasts of more than 100 kinds of plants in the world have been regenerated to produce seedlings. More than 50 kinds of plants produced interspecific or intergeneric regenerated seedlings through protoplast cultivation. In China, regenerated seedlings of major crops through protoplast cultivation include rice, wheat, maize and potatoes, among others. Also more than 20 kinds of farm produce including cucumbers, cabbage, mustard, tomatoes, eggplants, tobacco, rape, alfalfa, Lotus corniculatus (L.var.japonicus), and chuanxiong rhizome (Rhizoma Ligustici Chuanxiong) seedlings have been regenerated from protoplast cultivation. Interspecific and intergeneric cell hybrid seedlings obtained through cell fusion are produced from ordinary tobacco and yellow flower tobacco, and between ordinary tobacco and light blue tobacco. Lanzhou University's Research Institute of Cellular Biology recently obtained wheat protoplast seedlings with distant hybridization characteristics through cellular hybridization.

Somatic cell selection by asexual mutation: Asexual mutation in many plant somatic cells (recovered tissues or protoplasts) produces many characteristics with economic value, such as anti-disease, dwarfism, anti-involuting, and high yield. This has become very significant to the farm-produce breeding specialists in China. Many breeding applications have provided many improvements. For example, the Gene Physiology Institute of the Jiangsu Academy of Agricultural Sciences uses live antigen bacteria to select from tissue recovering from pressure damage. In 1983, the institute obtained anti-hoja-blanca wheat mutation cell systems. At present it has reached the sixth generation and still possesses medium-to-high anti-disease characteristics, showing that anti-disease characteristics have been inherited by offspring. The Wheat and Rice Institute of the Fujian Academy of Agricultural Sciences has used coarse extracts of rice-blast bacteria as an externally imposed threat. Through in vitro mutational selection of rice cellular asexual systems or pollen cultivation antigenic mutational selection, anti-rice-blast mutational somata were produced. Also, the Institute of Crop Research of the Chinese Academy of Agricultural Sciences has used 0.1 percent and 0.3 percent NaCl [solutions] on cultivation medium. This selected out many salt-resistant wheat and black-wheat strain systems.

Plant gene engineering: Gene manipulations at the molecular level can transform genes at interspecific, intergeneric and interfamily levels. Transformations may even occur between animals, plants, and microbes. This greatly enhances the progress of directional breeding of strains. The possibility of obtaining better strains is raised. Also, farm produce can follow human directives in producing various products. As to plant gene-engineering gene carriers, Ti plasmids of soil agrobacillus species are widely used in China as a carrier, achieving advances in the introduction of exogenic genes. The Biotechnology Research Center of the Chinese Academy of Agricultural Sciences has developed a transformation system consisting of exogenic plant tissues such as leaf whorls, stem whorls and petioles. This has greatly facilitated the introduction and expression in plants of exogenic genes. The Shanghai Biochemistry Institute of the Chinese Academy of Sciences has suggested the technique of introducing exogenic DNA through pollen tubes or injecting it into plants; this technique has been used on cotton and rice seedlings for many years. This successful transfer of genes with anti-disease or other characteristics resulting in new series of strains has developed to large-scale testing for 7 to 10 generations. For example, cotton strain number 3118 has high anti-wilting ability, and has high resiliency against yellowing and wilting. Rice strain number 829042 has excellent characteristics such as early maturation, resistance to drought and disease, and vertical growth. This method of breeding the strains has shortened the breeding time to about one half that of ordinary methods. In 1988, the Microbiology Institute of the Chinese Academy of Sciences successfully transformed tobacco cells through the use of tobacco mosaic virus (TMV) exterior proteinous gene Ti plasmids. The result was 112 anti-disease tobacco plants with transformed genes. In 1988, the Biotechnology Center of the Chinese Academy of Agricultural Sciences used BT toxic protein to transform rice protoplast and obtained rice plants with transformed genes. After marked gene determination, the rice tissues showed insecticidic proteinous genes.

Furthermore, the root nodule bacteria of legume root nodules have nitrogen-fixation properties. They can

assist plants in obtaining nitrogenous nutrition. In nitrogen-fixation research, a number of advances have been made.

The production of metabolic products and the development and use of biological matter: In using large-scale cultivation techniques on cells, we can produce many types of second-generation plant metabolic products such as alkaloids, pigments, fragrances, food additives (such as tinctura capsici, ginger-oil ketones, and sweeteners) and active ingredients in Chinese herbal medicine. These can become raw materials for the medical, food, and cosmetic industries. China has more than 20 establishments in this line of work, and has made some achievements. For example, research on ginseng cells has reached the intermediate testing stage. Pharmaceutical-biological transformation of Digitalis cells has produced stable cellular strains.

Utilizing solar energy, photosynthesis in green plants transforms $CO_2$ and $H_2O$ into biological materials. In conventional crop production, economic output is a little more than one-third of biological output. Much of what exists is in the form of cellulose, half-cellulose, and wood fibers. China's annual yield of 400 million tons of food means at the same time the production of 500 million tons of stalks. Most of these stalks from the fields have not been put to use. If enzyme engineering and fermentation techniques are applied to process stalks, then we can obtain edible mushrooms, sugar and feed protein among other useful products. Among these approaches, transforming biological materials into edible mushrooms has had the most success. According to surveys, in the parts of southwestern China where rice fields produce a thousand jin [1 jin = ½ kg] per mu, they also produce one jin of mushrooms from one jin of hay. Also, the remaining hay contains large amounts of mycelia, a good source of feed protein. In addition, China is using sugar residues and other industrial waste products to produce monocellular protein, and has established factories to handle a 10,000-ton level of production.

Zoological techniques: Injecting growth hormones into farm animals can increase their growth rate, and therefore advance their delivery time. Increased milk volume and leaner pork can be obtained as well. Because animal growth hormones are scarce in their pituitary glands, much exploration of production through gene-engineering bacteria has been going on in and outside China. Beijing Agricultural University has already introduced pig growth-hormone genes into Bacillus coli and obtained expression. The Institute of Hydrobiology of the Chinese Academy of Sciences has introduced human growth hormone genes into loaches, and has observed an accelerated growth rate of two to three times normal. This type of technique has been applied to fish, rabbits, pigs, and sheep and has been successful, opening new avenues for the cultivation of high-yield farm animals and fowl.

Farm-animal embryo engineering, including embryo transplantation, surrogate pregnancy, embryo division, in vitro fertilization, and sex control, are new techniques in breeding farm animals. Under natural conditions, one cow can only produce about 10 progenies in its lifespan. If we use superovulation and embryo transplantation techniques, we can obtain more than five times the number of calves. In China, embryo transplantation in farm animals such as cows, sheep, pigs, and rabbits, and embryo freezing in farm animals such as cows, sheep, and rabbits have been successful. Inner Mongolia University has produced the world's first "test-tube goat," then cultivated sheep ova in vitro and successfully fertilized them, producing "test-tube sheep." This has provided an effective way to mass-produce farm-animal test-tube embryos.

In veterinarian use of gene-engineered vaccines, China has successfully produced gene-engineered joint bacteria that carry both the K88 and K99 factors, the piglet Bacillus coli diarrhea adherence genes. When pigs are injected with 2 billion gene-engineered bacteria, piglet protection after administering high dosages was 100 percent. Seventy percent of the control group died after administration [of the bacillus].

In the improvement of fish and shrimp, China has obtained female-nucleus-developed fish with Ctenopharyngodon idellus, Hypophthalmichthys molitrix, and the common carp. The male Luofei fish group obtained in China has a level of production 40 percent higher than natural bisexual groups.

New examination methods: Application of biological techniques includes the above-mentioned introduction of exogenic genes into plant and animal bodies to directly improve the strains. It also includes indirect uses, namely, the development of some quicker and more accurate diagnostics in plant and animal diseases, including the use of monoclonal antibodies. Another example is the use of some new techniques to distinguish superior parent characteristics, and incorporating them in regular breeding items. At present, China has produced the following monoclonal antibodies to counter the following: tobacco mosaic virus (TMV), potato Y virus, potato X virus, plant green wilting bacteria, rice white leaf wilting bacteria, and others. In Inner Mongolia, Northeastern China and the Tianjin region, monoclonal-antibody techniques have been used in the disinfecting of potato stem tips, or the virus inspection of potatoes being imported or exported with satisfactory results. The Biotechnology Institute of the Chinese Academy of Agricultural Sciences has used monoclonal antibodies to divide the strains of potato Y virus in eight provinces, cities, and autonomous regions, and has obtained satisfactory results. Zoologically, China has developed specific monoclonal antibodies against equine infectious anemia, Brucella, and foot-and-mouth disease.

It can be seen that biological techniques in China in fields such as agriculture, animal husbandry, and fisheries have produced demonstrable results, and have provided great assistance to farming. Scientists predict that biological techniques will lead to a new green (botanical), white (dairy), and blue (fisheries) revolution in farming. Since all

countries are in fierce competition, in order for biological techniques to play an even more significant role in China, more emphasis has to be given to research in the area. It has to be based on the needs of China's farming; especially important is the application of biological techniques in the following areas: development of high-quality, high-yield, multiply-resistant crops; new feed crops; new breeds of high-quality, high-yield, low-consumption farm animals and fowl; providing new test reagents in the diagnosis and treatment of animal and plant diseases; and emphasizing the employment and utilization of crop stalks to create new food and feed sources. In research, it is important to incorporate biological techniques and ordinary approaches, conduct collaborative research in molecular and cellular sciences. These approaches can produce more and better products from agriculture, animal husbandry, and fisheries, and in turn allow the agricultural application of biological techniques to reach new heights.

## New Center To Promote Technology Established

*40100033A Beijing CHINA DAILY in English 12 Mar 90 p 3*

[Article by staff reporter Zhang Lin]

[Text] China's National Research Centre for Intelligent Computing Systems was set up on Friday in Beijing. Its aim is to pool the country's best computer scientists and resources, to promote research and development in this strategically important high-technology field.

The establishment of the centre is part of the effort to realize China's ambitious scheme of narrowing the gap with the West and then getting an upper hand in seven high-technology areas in the 21st century.

The seven high-tech areas include biology, space technology, information, lasers, automation, energy and new materials.

The major tasks for the centre are to conduct basic research and develop key products in the intelligent computing systems, in line with the country's high-tech development scheme, said Li Guojie, director of the centre, at the opening ceremony.

From now to 1992, the centre will focus its efforts on the development of parallel and compatibility intelligent workstations, Li said.

Besides basic research, the centre will co-operate with the country's industrial sectors in order to quickly manufacture and market the products that have resulted from its research at each stage, Li said.

To realize this goal, the centre will welcome co-operation from micro-electronic and computer scientists and research institutes from other countries, he said.

In May, the centre will sponsor an international symposium on the development strategy of intelligent computing systems.

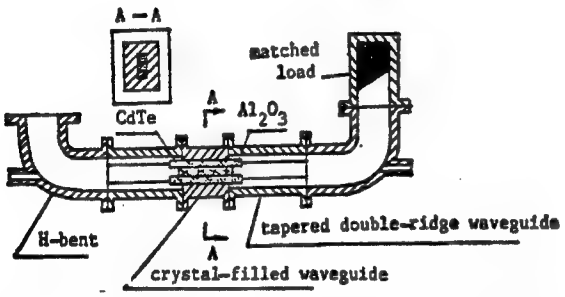
The centre will also spend $4.9 million in the next two years to introduce an advanced computer network, workstations, software and other equipment, CHINA DAILY learned.

## Obtaining, Measuring Tunable Sidebands of $CO_2$ Laser

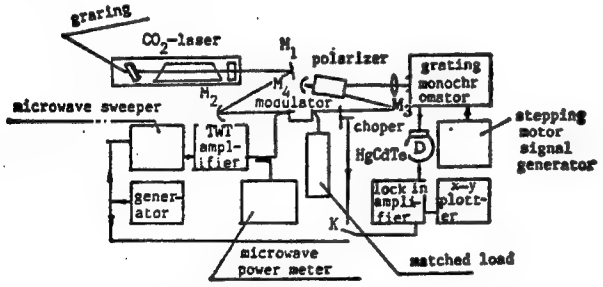
*40090008a Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 30-35*

[English abstract of article by Han Jiande [7281 0256 1795], et al., of the Department of Physics, Dalian University of Technology; Wu Guilin [0702 2710 2651], et al., of the Laser Section, Dalian University of Technology]

[Text] By using a traveling-wave electrooptic modulator containing a CdTe crystal to mix the tunable microwave and $CO_2$ laser output, directly readable frequency sidebands are obtained which are tunable on either side of the $CO_2$ laser lines over 4.4 GHz regions. Measurements show that the characteristics of the sidebands are in good agreement with those predicted by the corresponding theory.




**Structure of Traveling-Wave Electrooptic Modulator**




**Experimental Block Diagram**

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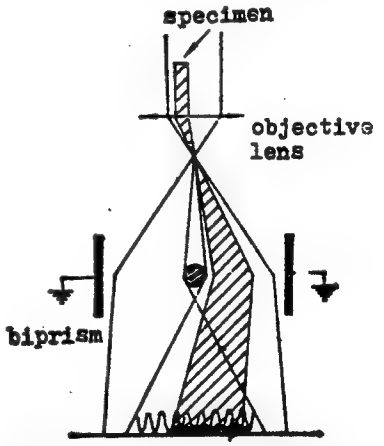
## Observation of Electrostatic Field Generated by Point Charges, Measurement of Charged Quantity by Electron Holography

*40090008b Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 36-41*

[English abstract of article by Chen Jianwen [7115 1696 2429] of the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] A simple and easy method is used to prepare the electrostatic field specimen in this paper. Due to physical factors, some dielectric particles supported by thin carbon films, e.g., polystyrene latex spheres 0.31 μm in diameter, will become charged bodies during electron microscopic observation because of electrostatic accumulation. Under the electron beam, spheres of radius $r$ obviously acquire a stationary positive charge $Q$, and the resulting field can be simply modeled by a point charge $Q$. With the field model, the electrostatic field distribution is observed and the magnitude of the charged quantity is determined by electron holography.




**Schematic of Electron Biprism**

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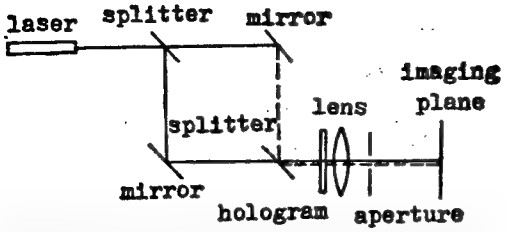


**Optical Reconstruction System for Phase Difference Amplified in Electron Holography**

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## Research on Modulated Beam Holography

*40090008c Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 47-52*

[English abstract of article by Cai Yunliang [5591 0061 5328] of the Department of Mathematics, Physics and Mechanics, Nanjing Aeronautical Institute]

[Text] The modulating effects of holographic plate motion on recorded beams and on measuring results are proposed in this paper. The mathematical expressions for intensity distribution are derived for the double exposure interferogram and are recorded with the beams modulated by the holographic plate motion. Based on the theoretical study of the formation of the modulated fringes, the holographic analytical method of the measured object's three-dimensional displacement field is proposed. The plate displacement is determined with the help of the reference body.

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## Two Gradient-Index Microlenses Made by Ion Exchange Method

*40090008d Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 60-66*

[English abstract of article by Gao Yingjun [7559 2019 0193] and Qin Yali [6009 0068 7787] of Xian Institute of Optics and Precision Mechanics, Chinese Academy of Sciences]

[Text] A solution to the diffusion equations for window and disk mask problems is found by fabricating planar microlenses, and the optimum refractive index distribution for disk-mask microlenses is derived. The image matrix of the microlens is given in the paper. The authors fabricated a disk-mask microlens array, and the parameters and a photo taken by the array are presented.

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## Theory, Optimum Design for Optical Waveguide Filter

*40090008e Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 74-78*

[English abstract of article by Lian Hanxiong [6647 3352 7160] of the Radio Engineering Department, Beijing Institute of Posts and Telecommunications]

[Text] A novel construction and theory of the optical waveguide filter are presented in this paper. The optimum design of the filter can lead to obtaining the size of the structure directly. An optical waveguide filter with a maximum flat response at a central wavelength of 1.55 μm and a bandwidth of 22 nm is obtained. The calculation in the design is simple and can be used for the filter construction. Since the design takes the geometrical discontinuity of each guide into account, the accuracy of the results is better than that of the EDC method.

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## Effect of $Cl^-$, $ZnCl_4$= Ions on Ultrafast Supercontinuum Generation in Water

*40090008f Shanghai GUANGXUE XUEBAO [ACTA OPTICA SINICA] in Chinese Vol 10 No 1, Jan 90 pp 92-96*

[English abstract of article by Chen Daoyang [7115 6670 7122], et al., of the Department of Physics, Fudan University, Shanghai; Wang Runwen [3769 3387 2429] of the Shanghai Institute of Optics and Fine Mechanics, Chinese Academy of Sciences]

[Text] The spectral distributions of an ultrafast supercontinuum laser [USL] from aqueous solutions of NaCl, KCl, $ZnCl_2$ and $K_2ZnCl_4$ at several concentrations have been studied using a 35-psec laser pulse at 1.06 μm. In the visible region the spectral distribution of the USL from $H_2O$ is strongly affected by halides. The main features are a significant increase in SRS intensity by $Cl^-$ and effective spectral broadening due to the formation of the complex anion $ZnCl_4$= in concentrated $ZnCl_2$ and $K_2ZnCl_4$ solutions.

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## Progress in Fiber-Optic Communications

### Nanjing-Wuhan Line Formally Open

*40080013A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 15 Feb 90 p 1*

[Article by Chen Hongyi [7115 1738 3015] and Shang Cuiyun [1424 5050 0061]]

[Summary] The 1,000-kilometer-long Nanjing-Wuhan segment of China's first long-distance, high-capacity digital fiber-optic communications line—the 2,200-kilometer-long Nanjing-Wuhan-Chongqing fiber-optic cable, spanning five provinces and linking 16 cities—is now formally operational. The completion of the Nanjing-Wuhan underground cable, whose laying was completed by the end of 1989, will greatly alleviate the overcrowded conditions along the eastern seaboard, especially in the Changjiang river basin.

The optical fiber is made of drawn quartz glass only one-third the thickness of a human hair, and the optical cable is of the 12-core (i.e., 12-fiber) type. Each two fibers compose one optical-circuit digital communications system, and each system can simultaneously connect 1,920 pairs of speakers. The 12-fiber cable can therefore carry over 10,000 simultaneous telephone conversations.

### Third-Generation Bundle-Tube-Type Optical Cable Developed

*40080013A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 15 Feb 90 p 2; Beijing RENMIN RIBAO in Chinese 19 Jan 90 p 2*

[Articles by Cheng Renyi [2110 0088 5030] and Fei Weiwei [6316 0251 0251], respectively]

[Summary] The model GYTB33 third-generation bundle-tube-type [shu guan shi 2631 4619 1709] fiber-optic cable [apparently a generic description of a type or types of cable comprised of fiber bundles with tubes for stiffening], jointly developed by North China Jiaotong University's Lightwave Technology Institute, Beijing Cable Plant, and Beijing Plant 605, passed technical appraisal in Beijing on 18 January. This state-of-the-art cable is a new-generation type whose technology has been mastered by only a very small number of nations, including the United States, Japan, and the FRG. The project, listed in the Beijing Municipal Torch Plan, was completed in the extremely short period of 3 months by a team led by Professor Jian Shuisheng [4675 3055 3932], director of the Lightwave Technology Institute.

This third-generation cable has high mechanical strength, good low-high-temperature characteristics, and good longitudinal hermetic qualities, is low in bulk, lightweight, and uses only one-fourth the raw materials required by the previous-generation optical cable. Compared to similar foreign products, this cable's resistance to lateral pressure is basically the same and its tensile strength is superior; in its construction, it has been designed to be effective in resisting nuclear electromagnetic pulse [EMP] effects and in resisting lightning. It can be strung overhead, laid in ducts, or directly buried.

## Overview of Plasma Fusion Research

*90CF0269A Beijing WULI [PHYSICS] in Chinese*
*Vol 18 No 10, Oct 89 pp 629-633, 638*

[Article by Cai Shidong [5591 6108 2639] and Li Yinan [2621 6892 1344] of the Institute of Physics, Chinese Academy of Sciences; and Hong Mingyuan [3163 2494 5373] of the National Natural Science Foundation]

[Excerpt] Abstract: This paper describes the status of China's research in nuclear fusion and high-temperature plasmas, basic plasmas, astronomical plasmas, space plasmas, low-temperature plasmas and applications of all these plasmas, as well as plasma theory in China. In addition to describing the experimental-setup parameters and major diagnostic equipment, current research topics in experiment and theory are also described briefly.

In China, research on nuclear fusion and plasmas began in 1958 and progressed to the 1970's, when work on space plasmas started. In recent years, research on the application of plasmas has also began. Research units engaged in nuclear fusion, space plasmas, and plasma application are listed below:

(1) Research units in the Chinese Academy of Sciences include the Hefei Institute of Plasma Physics, the Institute of Physics, the Institute of Mechanics, the Institute of Electrical Engineering, the Institute of Electronics, the Shanghai Institute of Optics and Fine Mechanics, the Institute of Space Physics, the Institute of Geophysics, Beijing Observatory, Nanjing Zijinshan Observatory, Yunnan Observatory, the Institute of Chemistry, Chengdu Organic Chemistry Institute, Changchun Institute of Applied Chemistry, and Guangzhou Institute of Chemistry.

(2) Units in the industrial system of China include Southwestern Institute of Physics, the China Institute of Atomic Energy, research institutes in the Ministry of Aeronautics & Astronautics Industry, Beijing Institute of Automation under the Ministry of Machine-Building Industry, the Institute of Chemical Power Supplies under the Ministry of Light Industry, and the Shanghai Textile College.

(3) The university system consists of more than 40 universities and colleges including the China University of Science and Technology, Beijing University, Qinghua University, Fudan University, Nanjing University, Dalian University of Science and Engineering, and others. Most of these universities have developed applied research on plasma.

A brief description of the research is given below.

### I. Experimental Study of Nuclear Fusion

1. Tokamaks

Tokamaks are the main topic of study in China's nuclear-fusion program. Nine tokamak experimental facilities are currently in operation.

(1) Tokamak CT-6B

This is an improved version of the first tokamak in China, the CT-6 Tokamak, put into operation by Institute of Physics of the Chinese Academy of Sciences in 1974.

The CT-6B has iron-core transformers but no conducting shell. The main parameters are as follows: a 45-cm major radius, a 10-cm plasma minor radius, a 13-kG longitudinal field, magnetic flux in the transformer=0.28 Wb, plasma current=30 kA, current pulse width=20-100 ms, electron temperature=200 eV, electron density=(1-4)x$10^{13}$ $cm^{-3}$, energy confinement time=1-2 ms, and particle confinement time=3-5 ms.

The diagnostic equipment includes soft and hard X-ray probes, soft X-ray imaging devices, laser fluorescent spectrometers, vacuum ultraviolet spectrometers, visible-light spectrometers, multichannel diode optical probes, $LiTaO_3$ probes, quadrupole mass spectrometers, Rogowski loops, Mirnov probes, sine-cosine magnetic probes, neutral-particle-energy spectrometers, electron-cyclotron-emission measurement instruments, ruby Thomson-scattering instruments, far-infrared laser interferometers and scattering-measurement instruments, far-infrared Faraday-rotation measurement devices, and microwave-interference measurement instruments, plus the associated data-acquisition systems and computerized automatic control systems.

Current topics of study include (1) Electron cyclotron resonance heating (ECRH), (2) Alfven-wave heating, (3) low-frequency modulated current driving, (4) energy and particle transport, (5) electron diffusion under the condition of magnetic-island-type random-orbit structures, and tokamak experiments with random limiters. Recently, plasma microwave heating experiments were performed using a gyroton with a frequency of 34.34 MHz, a pulse width of 10 ms, and an output power of 200 kW. The heating results were quite pronounced.

(2) HT-6B Tokamak

In 1981, the Hefei Institute of Plasma Physics of the Chinese Academy of Sciences put into operation a hollow-core-transformer tokamak. Its major radius is 45 cm, the plasma minor radius is 12.5 cm, the longitudinal field is 10-12 kG, the plasma current is 40-50 kA, the plasma electron temperature is 200-300 eV, and the average density of the plasma is (2-3)x$10^{13}$ $cm^{-3}$.

The diagnostic equipment includes an ECH heating device, a 4-mm microwave interferometer, a visible-light and near-ultraviolet space-scanning dual monochromator, high-speed photographic instruments, a vacuum ultraviolet space-scanning spectrometer, radiation-measurement equipment, Rogowski loops, Langmuir probes, hard X-ray detectors, soft X-ray fluctuation

monitors, Thomson-scattering equipment, a charge-exchange neutral-particle-energy spectrometer, an HCN interferometer, an ECE measurement device, a Doppler-broadening spectrometer, a soft X-ray energy spectrometer, and data processing systems.

Major efforts include (a) reducing impurities in the plasma ($Z_{eff}$ approximately equal to 1), (b) suppressing MHD [magnetohydrodynamic] instabilities caused by the tearing mode via application of an external helical field and ECRH local heating.

(3) HT-6M Tokamak

In 1984, the CAS Hefei Institute of Plasma Physics put into operation another tokamak. Its main parameters are: major radius 65 cm, plasma minor radius 20 cm, longitudinal field 15 kG, plasma current 150 kA, discharge sustaining time 150 ms, plasma electron temperature 600-800 eV, plasma ion temperature 300-400 eV, average plasma density (5-7)x$10^{13}$ $cm^{-3}$, and energy confinement time 10 ms.

Its major efforts have included (a) high-power supplemental heating experiments (including 1-MW neutral-beam-injection heating, 1-MW ion-cyclotron-frequency high-frequency heating, 100-kW electron-cyclotron-frequency high-frequency heating, and current distribution), (b) plasma equilibrium and stability experiments at a high specific pressure, (c) low-mixture wave-current drive experiments, and (d) plasma-transport process and boundary-layer physics experiments.

(4) HL-1 Tokamak

This is China's largest tokamak and was put into operation by the Southwest Institute of Physics in April 1985. Its main parameters include a major radius of 102 cm for the inner and outer vacuum chamber, a minor radius of 25-27 cm for the inner vacuum chamber (corrugated duct, 0.05-cm wall thickness), a minor radius of 32 cm for the outer vacuum chamber (copper shell, 5-cm wall thickness), an aperture radius of 20 cm, a longitudinal field of 5T along the axis of the large ring, 16 longitudinal-field modules, and a maximum transformer stem flux change of 1.75 V . s [volt-seconds]. The following plasma parameters have been achieved: main field 34 kG, plasma current 220 kA, average time of plasma current 400 ms, duration of plasma current 1.3 s, plasma density 4.7x$10^{13}$ $cm^{-3}$, electron temperature 1.8 keV, ion temperature 870 eV, effective charge number 1.5, safety factor 2.8, and energy confinement time 16 ms.

Diagnostic equipment includes electromagnetic measurement systems (e.g., Rogowski loops, single-turn coils, displacement probes, a polar magnetic probe set, a circumferential magnetic probe set), soft X-ray diode arrays and absorption comparison detector probe arrays, an HCN multichannel interferometer, a multi-frequency and multichannel microwave interferometer, laser scattering [instruments], multichannel $H_\alpha$ (laser gas-blowing devices), a multichannel calorimeter, electrostatic probes, a calorimeter, an effective-Z meter, a single-channel microwave (2 mm and 4 mm) interferometer, a SiLi spectrometer, a neutral-particle analyzer, an ECE meter, a vacuum ultraviolet spectrometer, a bent-crystal spectrometer, lithium-beam probes, ECRH measurement devices, a surface-analysis station, a VAX/750 computer dedicated to data processing, etc.

Topics for physics and engineering research include equilibrium experiments, measurement and expansion of the stable-operation zone, long-pulse-discharge experiments, current driving, stability experiments, heating experiments, discharge-cleaning experiments with container walls, titanium-spray experiments, research on interaction of plasmas and container walls, impurity control, study of main-machine engineering, secondary aeration, and preionization-discharge experiments.

(5) Small tokamak micro-ring, pretest ring, and KT-5

The first two devices were installed in the Southwest Institute of Physics, and the last device was installed in the China University of Science and Technology. The main parameters are listed below in Table 1.

**Table 1**

| Main Parameter | Micro-Ring | Pretest Ring | KT-5 |
|---|---|---|---|
| Major radius R(cm) | 20 | 26 | 30 |
| Minor radius a(cm) | 4.5 | 75 | 10 |
| Longitudinal field $B_t$ (kG) | 12 | 20 | 4.5 |
| Plasma current $I_p$(kA) | 15 | 12 | 5 |
| Plasma density n($cm^{-3}$) | — | 10x$10^{13}$ | — |
| Electron temperature (eV) | 40 | 30 | 50 |
| Energy confinement time $\tau_E$(ms) | — | 10 | — |
| Transformer core | air | iron | air |

The main topics of study have included rupture and escaping electrons, RF heating, major-radius compression, propagation of ionic Bernstein waves and the interaction between the plasma and the container wall.

(6) Toroidal multipole tokamak MPT-X

This tokamak, located in the Hefei Institute of Plasma Physics, has four sets of internal conductor rings. Its main parameters are: major radius 40 cm, plasma minor radius 8 cm, plasma current 60 kA, discharging duration 30 ms, longitudinal field 10 kG, electron temperature of plasma 100 eV, plasma average density 1x$10^{13}$ $cm^{-3}$.

Major topics of research with this tokamak are (a) effects of the octopole field on the MHD instabilities of the

plasma in the tokamak, (b) the formation of a noncircular-configuration tokamak plasma using the octopole field and unsealed conducting shell, and the control of instability in the axisymmetric displacement, and (c) the reciprocal transition process between the tokamak operating state and that of the octopole field.

(7) Tokamak with noncircular cross-section

This is another device at the Southwest Institute of Physics. Its major radius is 48 cm, the cross section is 13 cm x 37 cm, and the longitudinal field is 4 kG.

2. Pinch and plasma focus

(1) Field-reversed pinch [device] FRP-1B

This facility, an expansion of the field-reversed pinch device FRP-1 built by the CAS Institute of Physics in 1984, is now in operation. The facility consists of the bias field, a pre-heating field, the main compression field, the lens field, the multipole field, the trigger field and the RF preionization source. The stored energy is 140 kJ.

Diagnostic equipment includes magnetic probes, anti-magnetic probes, a high-speed frame camera, spectrometers, and a Mach-Zehnder laser interferometer.

Research topics are concentrated in the formation of the field-reversed configuration and re-connection of magnetic lines of force.

(2) Field-reversed pinch [device] with a noncircular cross section

This facility is current in operation at the Southwest Institute of Physics. Its main parameters are: major radius 48 cm, minor radius 10 cm, longitudinal field 0.3T, rise time 200-500 μs, plasma current 80-130 kA, decay time 1-2 ms, plasma density $10^{13}$-$10^{14}$ $cm^{-3}$, plasma temperature 100 eV, confinement time $>100\mu s$, and specific pressure ratio about 0.1.

The principal diagnostic equipment includes various probes, spectrometers, multichannel soft-X-ray measurement equipment, a ruby laser Thomson scatterometer and interferometer, etc.

Current topics of research are the MHD behavior and mechanism of the plasma in the transition from $q<1$ to $q>1$.

(3) Small straight-tube angular-pinch device

This device has been installed at the China University of Science and Technology. The main task of this device is the measurement of time-space-resolved plasma electron density using a laser interferometer.

(4) Small high-voltage jet Z pinch device

This device is currently operating at Qinghua University. Its total capacitance is 1.3 μF, the maximum operating voltage is 150 kV, and the usual operating voltage is 80-100 kV.

(5) 200 kJ plasma-focusing device

This is another device currently operating at Qinghua University. The main parameters are: total capacitance 200μF, maximum operating voltage 50kV, and inner and outer radius of the electrode are respectively 230 mm and 270 mm. At an operating voltage of 300 kV and a peak plasma current of 1.5MA, the highest X-ray yield is 11J.

The principal diagnostic equipment includes a pin-hole camera, an MCP X-ray camera, an XRD (X-ray diode), and the X-ray yield-measurement system.

Research topics are currently concentrated in X-ray yield and mechanism and the plasma behavior in the propagation stage.

(6) 100 kJ plasma-focusing device

This device is also located at Qinghua University. Its main parameters are: total capacitance 99 μF, highest operating voltage 50 kV (usual operating voltage 21 kV), inner and outer radius of the electrode are respectively 65 mm and 150 mm. The X-ray yield has been found to be 11J.

3. Magnetic mirror

(1) Thermal electron-ring magnetic mirror

This device was first built in the CAS Institute of Physics and later moved to the Institute of Plasma Physics in Hefei. Its main parameters are field intensity at center of mirror 4-4.5 kG, mirror ratio 2.2-4, intermirror length 38 cm, microwave input power 8 kW, microwave frequency 20.4 GHz, vacuum chamber diameter 25 cm.

Main research topics are (a) formation and heating mechanism of thermal electron plasmas, (b) stabilizing effect of high-specific-pressure thermal electron ring, (c) perturbation of thermal electron plasmas under large mirror ratio.

(2) Research on magnetic mirrors is also being pursued at the Southwest Institute of Physics.

4. Cusped devices

Southwest Institute of Physics is developing research programs on high-frequency leakage prevention.

5. Inertial confinement

(1) For many years, the Shanghai Institute of Optics and Fine Mechanics [SIOFM] has been developing six-beam laser fusion experiments using neodymium-glass lasers. Each beam has an output power of $(5\text{-}10)\times10^{10}$ W and the FWHM [full-width at half-maximum] is 1ns/100ps.

Diagnostic equipment includes a one-dimensional space-resolution stigmator grazing-incidence-grating spectrometer, a transmission-grating spectrometer with pin-hole imaging, a Faraday-cup charge collector, an X-ray spectrometer, and an X-ray pin-hole camera. Research topics include fast ion emission, secondary harmonic emission, self-focusing and filamentous instabilities, density-profile steepening and self-magnetic field-effect theory, resonant absorption and stimulated Brillouin scattering. Soft X-ray lasing was obtained using the 5f-3d transition (105 Angstroms) of the $Al^{10+}$ ion.

Recently a two-beam neodymium glass laser with an output power of $10^{12}$ W was built and preliminary results have been obtained for short wavelengths.

(2) Electron-beam fusion experiment

The China Institute of Atomic Energy is pursuing research on electron-beam fusion. An 80 GW electron-beam accelerator has been built. Its electron energy is 1 MeV, the pulse width is 70 ns, and the beam current is 30 kA. Research topics include: pulse power technology, particle-beam inertial-confinement fusion, the electron-beam pinching effect in 46-kA diode with a cathode area of 38x5 $cm^2$ and an electron-beam cross-sectional area of 36x4 $cm^2$, measurement of electron-beam energy deposition on the target, and generation of an electron-beam-pumped KrF laser (19.5 J, 70-ns pulse width) and XeF laser (5 J energy). [passage omitted]

## Stimulated Transition Radiation Optical Klystron

*40090006a Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 39 No 1, Jan 90 pp 61-66*

[English abstract of article by Jiang Huabei [5592 5478 0554] of the Institute of High Energy Electronics, Chengdu Institute of Radio Engineering]

[Text] A new scheme for an optical klystron based on stimulated transition radiation is proposed. Calculations of spontaneous and stimulated emissions are made for this device using Madey's theorem in free electron lasers (FEL). The analysis in this paper shows that Madey's theorem can actually simplify the calculations and give clear physical concepts. The case of *N* medium sections cascaded through magnetic field dispersive sections is also discussed.

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## Two-Photon Pumped Six-, Four-Wave Mixing, Stimulated Radiation in Lithium Vapor

*40090006B Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 39 No 1, Jan 90 pp 76-81*

[English abstract of article by Wang Zugeng [3769 4371 6342] of the Department of Physics, East China Normal University, Shanghai]

[Text] This paper reports the generation of coherent and stimulated radiation in UV, visible and infrared regions by two-photon pumping. It includes the tunable coherent radiation around 1.03 μm generated by a special six-wave mixing process, the stimulated radiation at 812.6 nm generated by molecular two-photon dissociation or atomic cascade transition, and coherent radiation at 323.3 nm and 670.8 nm generated by four-wave mixing.

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## Substitution Effects, Neutron Diffraction Study of $YBa_2(Cu_{0.95}M_{0.05})_3O_{7-\delta}$

*40090006C Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 39 No 1, Jan 90 pp 111-118*

[English abstract of article by Yang Yingchang [2799 2019 2490], et al., of the Department of Physics, Beijing University; Yang Jilian [2799 4949 1670], et al., of the Institute of Atomic Energy, Beijing]

[Text] $YBa_2(Cu_{0.95}M_{0.05})_3O_{7-\delta}$ has been identified as single phase with M = Ti, V, Cr, Mn, Fe, Co, Ni, Cu and Zn. Substituting Fe, Co, Ni or Zn for Cu makes $T_c$ decrease significantly, while no destructive effect on $T_c$ has been observed when replacing the same content of Cu with Ti, V, Cr or Mn. The site occupation of the Ti, Mn, Fe and Co ions has been investigated by using the neutron diffraction technique, and a strong site preference for those ions was observed. Based on these results, the two different Cu sites and their relationship to the superconductivity in $YBa_2Cu_3O_{7-\delta}$ are discussed. The substitution effect for copper on the magnetic properties in $YBa_2(Ca_{0.95}M_{0.05})_3O_{7-\delta}$ and the correlation between magnetic and superconductive properties are reported.

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## Formation, Crystallization Mechanism of Glasses in $NaBO_2$-$B_2O_3$ System

*40090006D Beijing WULI XUEBAO [ACTA PHYSICA SINICA] in Chinese Vol 39 No 1, Jan 90 pp 129-137*

[English abstract of article by Liang Jingkui [2733 2417 7608] of the Institute of Physics, Chinese Academy of Sciences, Beijing, and the Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou; Fang Changming [2075 7022 2494], et al., of the Fujian Institute of Research on the Structure of Matter, Chinese Academy of Sciences, Fuzhou]

[Text] The formation, thermal stability and crystallization mechanism of glasses in the $NaBO_2$-$B_2O_3$ system have been studied by means of thermal analysis, X-ray powder diffraction at high and room temperatures, and IR absorption spectra. Stable glasses are formed easily in this system. The crystallization processes are related to the macroscopic state of the samples. The crystallization temperature of the bulk glasses is higher than that of amorphous powders. Some of the components crystallize as different phases, and they melt directly at different temperatures. The crystalline structure of the crystallization products is close to the glass structure.

The ionic conductivity in the $NaBO_2$-$B_2O_3$ system was determined by the ac impedance method. The conductivity of glasses is two to three orders higher than that of crystals with the same composition, while the activation energy of glasses is lower than that of the crystalline state for the same composition.

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## Superconductivity, Lattice Parameter, Thermal Characteristics of Yb-Ba-Cu(O,F) System

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[English abstract of article by Zhang Yuling [1728 3768 5376], et al., of the Institute of Physics, Chinese Academy of Sciences]

[Text] Superconductive samples with compositions of $YBBa_2Cu_3F_{2x}O_{7-x-\delta}$ ($0 <= x <= 1$) have been prepared. The variations of $T_c$, the lattice constants and the cell volume with the fluorine dose are described. The authors report an experimental observation of an increase in $T_c$ with a decrease of the oxygen content in the $YbBa_2Cu_3F_{2x}O_{7-x-\delta}$ ($0 <= x <= 1$). Therefore, with the oxygen content increasing, the lattice constants and cell volume with superconductor become larger. The higher the $T_c$, the larger the value of the lattice constants (b-a) of the orthorhombic structure. It is shown that the M-Cu-O or Cu-O parts of the systems may play an essential role in the superconductivity.

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